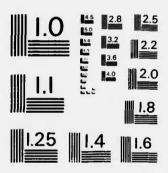
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**TECHNICAL REPORT RH-CR-83-6** 

A SURVEY OF ELECTRIC LASER CODES

Francis C. Wang Lockheed Missiles and Space Company, Inc. Hunts tille Research and Engineering Center 4800 Bradford Drive Huntsville, AL 35807

**JUNE 1983** 

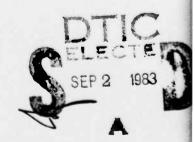
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U.S. ARMY MISSILE COMMAND Redstone Arsenal, Alabama 35898

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#### 18 SUPPLEMENTARY NOTES

The publication date is different from the performance period for this work. This delay in publication was caused by the Army's desire to include this work in a large report which contained all laser code surveys. However, such a task Was not completed.

19 KEY WORDS (Continue on reverse side if necessary and identify by block number)

Electric Lasers Computer Models

CO<sub>2</sub> Lasers

Gas Dynamics Optics

Pulsed Lasers

Excimer Lasers

CW Lasers

Kinetics

20 ABSTRACT (Continue on reverse side If necessary and identify by block number)

This report summarizes information gathered on a survey conducted by the Lockheed-Huntsville Research & Engineering Center under Tasks I and II, Contract DAAHO1-80-C-1289, on available computer codes which can be used to analyze electric laser devices. The laser systems include CO, CO, and excimers. operating in either the CW or pulsed modes. Technical areas surveyed include kinetics, optics, and gas dynamics.

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#### FOREWORD

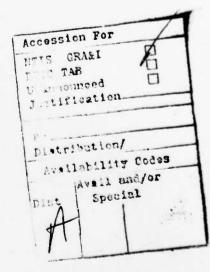
This report summarizes information gathered on a survey conducted by the Lockheed-Huntsville Research & Engineering Center under Tasks I and II, Contract DAAH01-80-C-1289, for the U.S. Army Missile Command, Redstone Arsenal, Alabama. This work was monitored by T.A. Barr, Jr. The period of performance covered by this report was from 1 July 1980 to 30 November 1980.

The author acknowledges many valuable conversations, assistance and encouragement provided by T.A. Barr, Jr., and J. Thoenes, as well as many others throughout this work. The author is also grateful to T.G. Roberts for his efforts in making publication of this report possible.

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#### 1. INTRODUCTION

Computer modeling has contributed greatly toward development of advanced technologies such as lasers and is expected to play an even more important role in the future. This is true as the computer models become more realistic, computation costs decrease, and as the number of design parameters increases, making optimization by laboratory search almost impossible.

Through the years, many computer codes have been developed for the analysis of laser systems and their components. Most of these codes are in the public domain, and individuals who wish to obtain copies of these codes can usually do so. However, due to the large number of codes available, selection of a proper code to fit the individual's need may be a difficult task.

Each computer code has been developed with its own purpose and its inherent limitations. Depending on the phenomena included, and the details of treatment of these phenomena, applicability of different codes vary. There are simple codes for laboratory data analysis. There are detailed engineering design codes. There are also systems codes which provide an end-to-end analysis. An understanding of the capabilities and limitations inherent in each computer code is thus important to the prospective user.

Besides the analytical treatment of the various phenomena involved in the code, the prospective user will require certain general information on how to use the code. The computer language used, the core memory requirement and the computer run time all influence the suitability of using a specific code.

To alleviate this difficulty, laser computer codes were surveyed. As part of the Army High Energy Laser 6.1 effort, a survey of laser propagation codes was performed in 1979 by J. P. Reilly of W. J. Schafer Associates, Inc. This survey was published by D. W. Howgate, C. M. Bowden, and T. G. Roberts (editors), in "New Laser Concepts Evaluation—Review," MIRADCOM

Technical Report DRCPM-HEL-79-4, Redstone Arsenal, Alabama, in February 1979. Unfortunately, the distribution of this report was limited to Government agencies only. An excellent survey of Continuous Wave Chemical Laser codes was performed by C. Wiggins, D. Mansell, P. Ulrich, and J. Walsh, and was published as "Chemical Laser Code Survey," BDM/TAC-79-769-TR-R1, BDM Corporation, Albuquerque, New Mexico, July 1980. More recently, two additional surveys were performed for electric laser codes and for pulsed chemical laser codes. The survey of electric laser codes reported herein, and the pulsed chemical laser code survey performed by Melvin Epstein and Robert R. Giedt of the Aerospace Corporation, were part of the Army High Energy Laser 6.1 effort.

In this study, we surveyed the industry for available codes which can contribute to the analysis of electric laser devices. The laser systems treated include CO, CO<sub>2</sub> and excimers, operating in either the CW or pulsed modes. The initiation may be self-sustained, E-beam initiated or UV-initiated. The flow system may either be open system, closed system or closed cycle. Technical areas surveyed thus include kinetics, optics, and gas dynamics.

Section 2 presents a general description of a high power electric laser system and its key components. The technical areas covered in this survey are then delineated. Section 3 presents a summary of the survey and its results. A general classification of the codes surveyed is also attempted. Section 4 presents the detailed return of all surveyed codes. Section 5 containes the references.

Participation in these surveys was voluntary, and therefore some existing codes may not be included. Also, as was pointed out by A. Garscadden in a private communication, references to the data banks and overview publications are not included. The reader may find many interesting references in the Selected Bibliography, Page 113.

This survey complements other previous code surveys covering areas of laser beam propagation (Ref. 1), chemical laser devices (Ref. 2), and pulsed chemical lasers (Ref. 3).

#### 2. PREPARING THE SURVEY

#### 2.1 COMPONENTS OF AN ELECTRIC LASER SYSTEM

A high power electric laser system can be delineated into different components as shown schematically in Fig. 1. The portion included in this survey is enclosed in the box entitled "Laser Device." It contains such components as gas supply and preparation subsystem, injector and mixing subsystem, cavity resonator, exhaust treatment and recirculation system, acoustic attenuation subsystem and electric power supply subsystem. Computer codes which can be used to provide analysis for processes and phenomena occurring in one or all of the above mentioned components are subjects of this survey.

#### 2.2 AREAS OF COVERAGE

A set of questionnaires was prepared to cover the technical areas of interest as well as information related to computer usage. A format similar to that used in Ref. 2 was adapted for use in this survey. Survey questions were grouped under the four headings of General Information; Optics; Kinetics; and Gasdynamics. Many of the questions used in the BDM survey are retained in this study.

Under the heading of GENERAL INFORMATION, questions are asked that relate to the purpose, unique capability, and limitations of the code. Questions are asked that relate to the availability of the code and its supporting documentation, as well as its computer compatibility. A key contact at the code residing organization is defined who may or may not be the originator of the code. No special effort was expended to identify the originators on all the codes surveyed, although in many cases it was necessary to communicate with the originators in order to obtain technical details about the code.

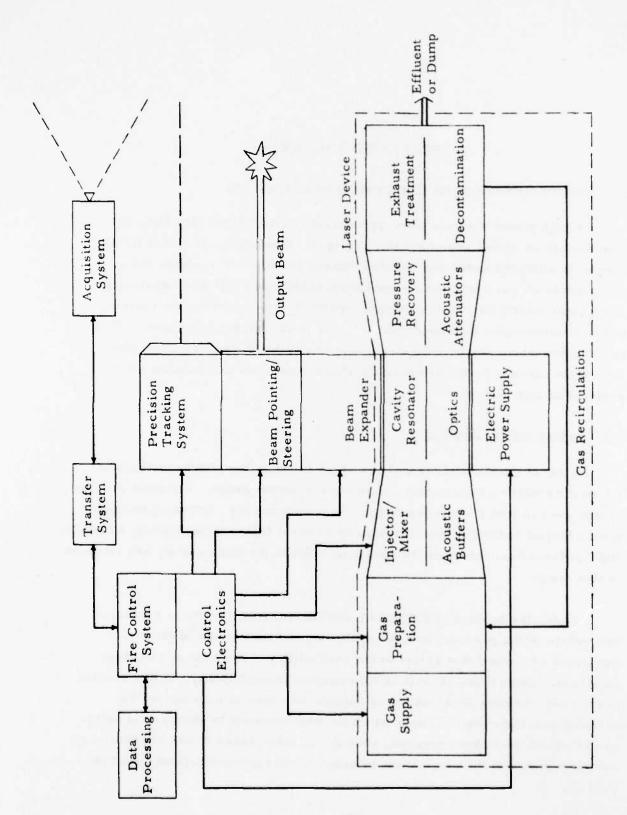


Fig. 1 - High Power Electric Laser System Components

Following the GENERAL INFORMATION section are questions grouped according to the technical areas covered by the code. Thus, a code return may contain any or all of the questions under Optics, Kinetics and Gasdynamics.

The questions under the heading of OPTICS deal primarily with the treatment of wave propagation within the laser resonator. Questions used in Ref. 2 were retained if they applied to the electric laser configurations.

The questions under the heading of KINETICS deal primarily with the treatment of plasma dynamics, lasing kinetics, and power extraction processes. Boltzmann codes used for electron energy distribution calculation and energy deposition codes for E-Beam systems are also included.

Questions under the heating of GASDYNAMICS deal primarily with the treatment of gas flow through the system and its interaction with the various components. The treatment of viscous mixing in the cavity, the acoustic propagation and its attenuation for a pulsed system, and pressure drops through the recirculation system are all included in this category.

#### 3. A SUMMARY OF ELECTRIC LASER CODE SURVEY

#### 3.1 INFORMATION GATHERING

A list of survey recipients was compiled from information obtained from several sources including the Army Missile Command, Naval Research Laboratory, Air Force Weapons Laboratory, and Air Force Wright Aeronautical Laboratories. This initial list of recipients was supplemented with additional names and organizations as the survey progressed, making a total of 55 organizations identified as survey recipients. These organizations include government laboratories, academic institutions, and private industries throughout the country. After having identified one or two individuals at each organization as the contact point for the survey, questionnaires were sent to all the identified organizations.

Phone conversations and personal visits to some survey recipients followed the initial mailing in order to speed up the survey return, to discuss fine points on the survey, and to clarify questions on the returned question-naires. In spite of all these followup activities, returns of the survey were slow. After much effort, 42 returned questionnaires were obtained. These returns, after being reviewed and retyped, are presented in Section 4. A summary of the survey results is given in the following subsection, in which an attempt is made to classify these codes.

#### 3.2 A CLASSIFICATION OF SURVEYED CODES

Forty-two of the electric laser related codes that were surveyed are generally classified as follows:

| Classification of Codes                               | No. o | f Codes |
|---|-------|---------|
| LASER KINETICS  |       | 21      |
| General excimer laser code                            | 5     |         |
| Specific excimer laser code                           | 3     |         |
| CO <sub>2</sub> laser code coupled to physical optics | 2     |         |
| CO, laser code  | 7     |         |
| General vibrational-rotational laser code             | 1     |         |
| CO laser code   | 3     |         |
| PLASMA KINETICS CODE                                  |       | 6       |
| ELECTRON KINETICS CODE                                |       | 6       |
| PULSE FORMING NETWORK CODE                            |       | 1       |
| LASER GASDYNAMICS                                     |       | 7       |
| Cavity gasdynamics                                    | 4     |         |
| Closed cycle gasdynamics                              | 3     |         |
| GENERAL OPTICS  |       | 1       |
| Total   |       | 42      |

A brief summary of all the codes surveyed is given in Table 1. Detailed returns of all codes are given alphabetically in Section 4. In the succeeding paragraphs, summaries for the different classes of codes are given.

The laser kinetics codes calculate the upper and lower state populations for the given lasing transition under the operating condition. The code may either be programmed to accept only a specific lasing transition or it may be more general in order to accept different reaction mechanisms from input data. Depending on its complexities, the code may contain mechanisms for the calculation of plasma kinetics, energy deposition, power extraction and gasdynamics. Most codes treat at least the Fabry-Perot resonator, a few (TDFI-EDL and UNSEDL2) have coupled physical optics which can treat other types of resonators as well. The laser kinetics codes are summarized in Table 2, where the applicable gas systems, the type of operation, and initiation method included in each code are listed. Also listed are comments related to specific features of the code.

The plasma kinetics codes deal with energy deposition into the cavity gas for either an E-beam discharge (E-BEAM TRANSPORT, EBAM2, and EBM2D) or discharge only (DENSITY, HGX80 and KINBOLTZ). Some may also be coupled to the pulse forming electric circuits (e.g., EBEAM2).

The electron kinetics codes are used to calculate the electron energy distribution function by solving the Boltzmann equation. Transport properties are then obtained from the distribution function. These codes are usually linked to the plasma kinetics codes or the lasing kinetics codes, thus forming a coupled code. Because of the different types of collision processes treated, the usage of these codes is thus considered case dependent.

The pulse forming network (PFN) codes provide electric current for the discharge pulse. Since the gas properties in the laser cavity affect the outside current, the analysis of PFN is usually coupled with the plasma kinetics codes for energy deposition calculation.

The gasdynamics codes are classified as either a cavity gasdynamics code or a closed cycle system gasdynamics. The cavity gasdynamics code treats the cavity gas medium homogeneity as the result of flow mixing in the

cavity, the acoustic wave generation due to the pulsed operation or non-uniform energy deposition. The system gasdynamics codes deal specifically with thermodynamics of closed gas systems. It provides transient analysis as well as steady state solution for the flow loop. The gasdynamics codes are summarized in Table 3 where the flow equations used and the special features treated are listed.

Of all the codes surveyed, only two have physical optics coupled with the lasing kinetics. This might be the result that many an analysis has been done with separate kinetics and optics codes. Extensive survey of optics codes as applied to resonator analysis and design has been conducted by BDM (Ref. 2) for chemical lasers. No duplication is intended in this study. A general optical system optimization code (ILLOPT) is included in this report.

# Table 1 SUMMARY OF ELECTRIC LASER CODE SURVEY

This table summarizes the 42 codes surveyed. Listed under each code is information pertaining to: the residing organization; the key contact; the principal purpose of the code; available documentation; and comments. Detailed returns of all codes are given alphabetically in Section 4.

Table 1
SUMMARY OF ELECTRIC LASER CODE SURVEY

| Code<br>Name | Residing Organization<br>Key Contact                         | Principal Purpose of Code  | Code<br>Classification                         | Documentation * | Comment            |
|--------------|--|--|--|-----------------|--------------------|
| BACPR        | Joint Inst. for Lab-<br>oratory Astrophysics<br>A. V. Phelps | To predict electron transport,<br>excitation, and ionization<br>coefficients from cross-section<br>data                                | Electron Kinetics                              | T, U, L, RP     |                    |
|              | (303) 492-7850   | 7700   |  |                 |                    |
| BMLASE       | Westinghouse R&D<br>Center                                   | To model the laser kinetics of a pulsed 14 $\mu$ m and 16 $\mu$ m CO <sub>2</sub> laser, and to predict its per-                       | (CO <sub>2</sub> )                             | T               | P                  |
|              | Lyle Taylor<br>(412) 327-5833                                | formance   |  |                 |                    |
| BOLTZ        | AFWAL  | To predict electron transport  | Electron Kinetics                              | Ü               |                    |
|              | CPT Gary L. Duke . (513) 255-2923                            | properties, excitation pump-<br>ing rates from given E/N and<br>cross-section data   |  |                 |                    |
| CCUBE        | U. of Alabama in<br>Huntsville                               | To compute flow properties throughout a closed circu-  | System Gas<br>Dynamics                         | RP              |                    |
|              | Gerald R. Karr<br>(205) 895-6330                             | lator for a steady state CW<br>laser   |  |                 |                    |
| COLASE       | Westinghouse R&D<br>Center                                   | To model the laser kinetics of a pulsed, electric dis-   | Laser Kinetics<br>(CO)                         | T, U            |                    |
|              | Lyle Taylor<br>(412) 256-5833                                | charge CO laser, and to pre-<br>dict its performance   |  |                 |                    |
| DENSITY      | AFWAL  | To determine the time de-  | Plasma Kinetics                                | None            | Time-Depend        |
|              | CPT Gary L. Duke<br>(513) 255-2923                           | pendent species concentra-<br>tion voltage, and current in<br>an XeCf laser plasma   | (XeCt)   |                 | Discharge<br>Model |
| E-Beam       | R&D Associates   | To model the E-Beam trans-   | Plasma Kinetics                                | T.U.L           | 2-D E-Beam         |
| Transport    | T. K. Tio<br>(213) 822-1715<br>X 448                         | port in the 2-D discharge gap<br>of an EDL under prescribed<br>E-field and B-fleld   |  |                 | Model              |
| EBEAM        | місом  | To compute time history of   | Laser Kinetics                                 | L.U             |                    |
|              | Arthur Werkheiser<br>(205) 876-8161                          | CO2 electric laser power out-<br>put for E-Beam lasers   | (CO <sub>2</sub> )                             |                 |                    |
| EBEAM2       | місом  | To compute time history of   | Plasma Kinetics                                | In              | Time-Depend        |
|              | Arthur Werkheiser<br>(205) 876-8161                          | E-Beam gun and sustainer<br>voltage and current from a<br>given power supply   |  | Preparation     | E-Beam<br>Model    |
| EBM2D        | місом  | To compute 2-D distribution  | Plasma Kinetics                                | т               | 2-D E-Beam         |
|              | Arthur Werkhelser<br>(205) 876-8161                          | of electron density, E-field,<br>and power deposited in an<br>electric laser cavity for a<br>given potential difference and<br>current | (CO <sub>2</sub> )                             |                 | Model              |
| EDLAMP       | Lockheed-Huntsville  | To predict cavity perform-   | Laser Kinetics                                 | T,U             |                    |
|              | Jürgen Thoenes<br>(205) 837-1800                             | ance of an E-Beam controlled<br>EDL  | (CO <sub>2</sub> ) Coupled<br>with Gasdynamics |                 |                    |
| EDLNOD       | AFWL   | To predict small signal gain   | Laser Kinetics                                 | L, RP           |                    |
|              | CPT Robert F. Walter<br>(505) 844-1786                       | and energy extraction for CO <sub>2</sub> EDLs   | (CO <sub>2</sub> )                             |                 |                    |

 $<sup>^{\</sup>bullet}$ T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

|              |  | Table 1 (Continue   | ed)                           |               |                                   |
|--------------|--|---|-------------------------------|---------------|-----------------------------------|
| Code<br>Name | Residing Organization<br>Key Contact   | Principal Purpose of Code   | Code<br>Classification        | Documentation | Comment                           |
| EDLSL        | AFWL<br>A. T. Gavrielides<br>(505) 844-4691  | To model the kinetics of photon production by a glow discharge in an EDL cavity   | Laser Kinetics                | None          |                                   |
| EED          | Tetra Corp.<br>Henry J. Happ, III<br>(505) 256-3595                                | To solve the steady state electron distribution function using the Boitzmann equation   | Electron Kinetics             | T, U, L       |                                   |
| ELECT        | Northrop R&T Center<br>William B, Lacina<br>(213) 377-4811<br>X 362                | To provide an analysis of elec-<br>tron kinetics for an arbitrary<br>gas mixture (possibly including<br>excited species) as a function<br>of electric field | Electron Kinetics             | T,U,L         |                                   |
| ELENDIF      | AFWAL<br>CPT Gary L. Duke<br>(513) 255-2923  | To compute electron distribu-<br>tion function, mean electron<br>energy drift velocity, and rate<br>coefficient   | Electron Kinetics             | T,U.L         |                                   |
| ETRANV       | Air Force Institute<br>of Technology<br>LTC William F.<br>Bailey<br>(513) 255-2012 | To provide time dependent solution of master equation for vibrational energy exchange for modeling of vibrational-rotational laser systems                  | Laser Kinetics<br>(General)   | RP            |                                   |
| FREESL       | R&D Associates<br>Peter Crowell<br>(505) 844-3013                                  | To compute development of free shear layer at interface of primary cavity flow and secondary injected beam duct flow in a confined channel                  | Cavity Gas<br>Dynamics        | T. L          |                                   |
| GALERK       | Joint Inst. for Lab.<br>Astrophysics<br>L. C. Pitchford                            | To predict electron transport<br>and excitation-ionization coef-<br>ficients from cross-section<br>data   | Electron Kinetics             | L.RP          |                                   |
| HGX80        | United Technologies<br>Research Center<br>William L. Nighan<br>(203) 727-7596      | To compute laser discharge properties in electrically excited rare-gas halide and mercury-halide lasers   | Plasma Kinetics<br>(Excimers) | L,RP          | Discharge<br>Model                |
| ILLOPT       | Westinghouse R&D<br>Center<br>Johanna Schruben<br>(412) 256-3611                   | Illumination evaluation and optimization of optical systems   | General Optics                | т             | Р                                 |
| KINBOLTZ     | Tetra Corp.<br>Henry J. Happ, III<br>(505) 256-3595                                | To compute the time dependent population levels in upper and lower states from rate equations   | Plasma Kinetics<br>(Excimers) | U, L          | Time-Depend<br>Discharge<br>Model |
| KINETIC      | Lawrence Livermore<br>Laboratory<br>W. Lowell Morgan<br>(415) 422-6289             | To model the basic laser<br>kinetics for E-Beam pumped<br>and discharge lasers  | Laser Kinetics<br>(Excimers)  | L             |                                   |
| KRF          | TRW Jeanette Betts (213) 536-1453  | To model KrF lasers and amplifiers  | Laser Kinetics<br>(KrF)       | L             | P                                 |
| LAGAD        | Westinghouse R&D<br>Genter<br>Martin J. Pechersky<br>(412) 256-7353                | To compute non-steady gas-<br>dynamics resulting from dis-<br>charge heating and flow loop<br>heat exchanger in a closed<br>cycle system                    | System Gas<br>Dynamics        | L             | Р                                 |

 $<sup>^{\</sup>circ}T$  = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.  $^{\circ\circ}Now$  at Sandia Laboratory.

Table 1 (Continued)

| Code<br>Name    | Residing Organization<br>Key Contact  | Principal Purpose of Code   | Code<br>Classification               | Documentation | Comment                                    |
|-----------------|---|---|--------------------------------------|---------------|--|
| LASER           | Northrop R&T Center<br>William B. Lacina<br>(213) 377-4811<br>X 362                 | General laser kinetics syn-<br>thesis and analysis for a broad<br>class of transient, electrically<br>excited laser systems | Laser Kinetics<br>(Excimers)         | T, U, L       |  |
| LASIM           | Westinghouse R&D<br>Center<br>L. E. Kline<br>(412) 256-7552                         | Simulation of UV initiated self-<br>sustained discharge pumped<br>XeF lasers  | Laser Kinetics<br>(XeF)              | L, RP         |  |
| мос             | U. of Alabama in<br>Huntsville<br>C. C. Shlh<br>(205) 895-6330                      | To compute transient flow associated with sudden energy deposition characteristic of pulsed laser operations                | Cavity Gas<br>Dynamics               | RP            |  |
| NRL<br>LASER    | Naval Research Lab.<br>Louis J. Palumbo<br>(202) 767-2255                           | Modeling of a variety of high<br>power gas lasers. Mostly<br>rare gas halides   | Laser Kinetics<br>(Exclmers)         | T. L. RP      |  |
| OPTEX           | Westinghouse R&D<br>Center<br>Dennis Suhre<br>(412) 256-7353                        | To predict the lasing outputs<br>for the 10 µm P(14) and P(18)<br>lines for a pulsed TEA laser                              | Laser Kinetics<br>(CO <sub>2</sub> ) | Т             | P  |
| POSEIDON        | Poseldon Research<br>James II. Morris<br>(213) 341-9172                             | To model 1-1) flow and acoustics in laser cavity and acoustic attenuation subsystem. (A 2-D version also exists.)           | Cavity Gas<br>Dynamics               | T, RP         |  |
| PSI<br>LASER    | Physical Science, Inc. Paul Lewis (617) 933-8500 also Raymond Taylor (617) 546-7798 | A series of general kinetics<br>codes for cavity gain and<br>power output calculations                                      | Laser Kinetics<br>(Excimers)         | RP            |  |
| REDAC           | Rocketdyne<br>E. Wheatley<br>(213) 709-7136   | To model PFN performance  | PFN                                  | U             | P  |
| STROBE          | R&D Associates<br>Bruce Masson<br>(505) 243-5609                                    | To model beam duct, cavity acoustics  | Cavity Gas<br>Dynamics               | T, L          |  |
| SUPER-<br>SONIC | Northrop R&T Center<br>William B. Lacina<br>(213) 377-4811<br>X 362                 | Analysis of an electrically<br>excited supersonic flow CO<br>laser  | Laser Kinetics<br>(CO)               | T,U,L         |  |
| TDF1-<br>EDL    | Lockheed-Huntsville<br>Jürgen Thoenes<br>(205) 837-1800                             | Th estimate performance<br>trends of a CW EDL with<br>unstable resonator  | Laser Kinetics (CO <sub>2</sub> )    | T.U           | Coupled Optics Kinetics and Gas Dy- namics |
| TEA             | Westinghouse R&D<br>Center<br>Lyle Taylor<br>(412) 256-5833                         | To model the laser kinetics of a pulsed 10.6 µm CO <sub>2</sub> laser and to predict its performance                        | Laser Kinetics<br>(CO <sub>2</sub> ) | T.U           |  |
| TELSAT          | R&D Associates Earl White (505) 844-8446  | To study steady state and<br>transient thermodynamic and<br>fluid dynamic system per-<br>formance                           | System Gas<br>Dynamics               | T, L, RP      |  |

 $<sup>^{</sup>ullet}_{T}$  = theory, U = user's manual, L = listing, RP = related publication, P = proprietary,

Table 1 (Concluded)

| Code<br>Name | Residing Organization<br>Key Contact                       | Principal Purpose of Code   | Code<br>Classification               | Documentation* | Comment  |
|--------------|--|---|--------------------------------------|----------------|--|
| UNSEDL2      | AFWL<br>CPT Ted Salvi<br>(505) 844-0256                    | Time dependent behavior of CW CO <sub>2</sub> EDL with mode-media instability | Laser Kinetics<br>(CO <sub>2</sub> ) | T.U.L          | Coupled<br>Optics, Kinetics<br>and Gas Dy-<br>namics |
| UVLZR        | Los Alamos Sci. Lab.<br>Arthur E. Greene<br>(505) 667-7799 | To study kinetics of rare gas<br>halide lasers, design more<br>efficient PFNs | Laser Kinetics<br>(Excimer)          | RP             | Coupled to<br>PFN                                    |
| VIBKIN       | Boeing Aerospace Co.<br>Donald J. Nelson<br>(206) 773-1498 | To model the kinetics of an electric discharge pumped supersonic CO laser     | Laser Kinetics<br>(CO)               | T.U.L          |  |
| XENON        | U, of Illinois T. DeTemple (217) 333-3094                  | Synthesis of E-Beam initiated<br>Ar-Xe laser                                  | Laser Kinetics<br>(Excimer)          | RP             |  |

 $<sup>^*</sup>T$  = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

# Table 2 SUMMARY OF LASER KINETICS CODES

This table summarizes the 21 laser kinetics codes surveyed. Listed under each code are information pertaining to: gas systems treated; type of operation; method of initiation treated in each code as well as comments.

Table 2
SUMMARY OF LASER KINETICS CODES

| Code Name<br>(Org.)      | Gas System<br>Treated         | Type of<br>Operation | Method(s)<br>of Initiation               | Comments  |
|--------------------------|-------------------------------|----------------------|--|---|
| BMLASE<br>(Westinghouse) | CO <sub>2</sub>               | Pulsed               | Self-Sustained<br>UV-Initiated           |   |
| COLASE<br>(Westinghouse) | со                            | Pulsed               | Self-Sustained<br>UV-Initiated           |   |
| EBEAM<br>(MICOM)         | CO <sub>2</sub>               | Pulsed               | E-Beam<br>Self-Sustained                 | Discharge Non-Uniformity<br>Treated   |
| EDLAMP<br>(Lockheed)     | CO <sub>2</sub>               | Pulsed, CW           | E-Beam Con-<br>trolled                   | Close Cycle Decontamina-<br>tion Treated  |
| EDLNOD<br>(AFWL)         | CO <sub>2</sub>               | Pulsed               | E-Beam                                   |   |
| EDLSL<br>(AFWL)          | CO2                           | Pulsed               | Self-Sustained                           | · =   |
| ETRANV<br>(AFIT)         | CO <sub>2</sub> , CO<br>HF/DF | Pulsed, CW           | E-Beam<br>Self-Sustained                 |   |
| KINETIC<br>(LLL)         | Excimers                      | Pulsed               | E-Beam<br>Self-Sustained<br>UV-Initiated | Boltzmann Solver Included<br>Extensive Graphics                                 |
| KRF<br>(TRW)             | KrF                           | Pulsed               | E-Beam                                   |   |
| LASER<br>(Northrop)      | Excimers                      | Pulsed               | E-Beam<br>Self-Sustained<br>UV-Initiated | Boltzmann Solver Included<br>Widely Distributed Code                            |
| LASIM<br>(Westinghouse)  | XeF                           | Pulsed               | Self-Sustained<br>UV-Initiated           |   |
| NRL LASER                | Excimers                      | Pulsed, CW           | E-Beam                                   | Boltzmann Solver Included   |
| (NRL)                    |                               |                      | Self-Sustained<br>UV-Initiated           | Reaction Scheme Specified<br>Using Symbolic Names for<br>Reactants and Products |
| OPTEX<br>(Westinghouse)  | co <sub>2</sub>               | Pulsed               |  | 10 μm P(14) and P(18) Lasing<br>Output Predicted                                |
| PSI LASER<br>(PSI)       | Excimers                      | Pulsed, CW           | E-Beam<br>Self-Sustained                 | A Series of General Kinetics  |
| SUPERSONIC<br>(Northrop) | СО                            | Pulsed, CW           |  | 1-D Gas Dynamics  |
| TDF1-EDL<br>(Lockheed)   | co <sub>2</sub>               | CW                   | E-Beam                                   | 1-D Gas Dynamics, Physical Optics   |
| TEA<br>(Westinghouse)    | CO2                           | Pulsed, CW           | E-Beam<br>Self-Sustained                 |   |

Table 2 (Concluded)

| Code Name<br>(Org.)   | Gas System<br>Treated | Type of Operation | Method(s) of Initiation                       | Comments                          |
|-----------------------|-----------------------|-------------------|---|-----------------------------------|
| UNSEDL2<br>(AFWL)     | CO2                   | Pulsed, CW        | E-Beam  | 2-D Gas Dynamics, Physical Optics |
| UVLZR<br>(LASL)       | Excimers              | Pulsed            | UV Preionized<br>Electron Impact<br>Avalanche | Coupled to PFN                    |
| VIBKIN<br>(Boeing)    | CO                    | Pulsed, CW        | E-Beam<br>Self-Sustained                      |                                   |
| XENON<br>(U, of III.) | Ar-Xe                 | Pulsed            | E-Bearn<br>Self-Sustained                     |                                   |

# Table 3 SUMMARY OF GAS DYNAMICS CODES

This table summarizes the seven gas dynamics codes surveyed. Listed under each code is information pertaining to: level of complexity; type of equations used; coordinate system; flow components treated, and special features.

Table 3
SUMMARY OF GASDYNAMIC CODES

| Code Name<br>(Org.)     | Level of<br>Complexity | Type of<br>Equations<br>Used | Coordinate<br>System | Flow<br>Components<br>Treated | Special Features<br>Modeled                                       |
|-------------------------|------------------------|------------------------------|----------------------|-------------------------------|---|
| CCUBE (UAH)             | Algebraic Model        | Viscous<br>Compressible      | 1-D                  | Closed Cycle                  | HX Compressors<br>Treated   |
| FREESL (RDA)            | Finite Difference      | Viscous<br>Compressible      | 2-D                  | Cavity Flow                   | Beam Duct Interface<br>Modeled                                    |
| LAGAD<br>(Westinghouse) | Algebraic (MOC)        | Compressible                 | 1-D + Time           | Closed Cycle                  | Single Pulse Acoustic<br>Treated                                  |
| MOC<br>(UAH)            | Finite Difference      | Viscous<br>Compressible      | 1-D + Time           | Cavity Flow                   | Single Pulse Acoustic<br>Treated                                  |
| POSEIDON<br>(Poseidon)  | Finite Difference      | Compressible                 | 2-D + Time           | Cavity Flow                   | Repetitive Pulse<br>Acoustic for an Open<br>System Can Be Treated |
| STROBE (RDA)            | Finite Difference      | Compressible                 | 3-D + Time           | Cavity, Beam<br>Duct          | Single Pulse Acoustic<br>Treated                                  |
| TELSAT<br>(RDA)         | Finite Difference      | Compressible                 | l-D + Time           | Closed Cycle                  | HX, Compressors<br>Treated  |

#### 4. DETAILED RETURN OF SURVEY QUESTIONNAIRES

This section presents in alphabetical order returned questionnaires of the 42 codes surveyed. The questionnaire for each code is organized in the order of GENERAL INFORMATION, KINETICS, GASDYNAMICS, and OPTICS. The information stated herein follows as close as possible to those provided. Since no technical information was provided on ELENDIF and REDAC, only general information is reported on these codes.

| CODE NAME:_  | BACPR                               | TECHNICAL AREA(S): Electron Kinetics                                    |
|--------------|-------------------------------------|---|
| DEVICE COMP  | ONENTS TREATED:                     |   |
| PRINCIPAL PU | RPOSE(S)/APPLICAT                   | TION(S) OF CODE: To predict electron transport,                         |
| excitation   | and ionization                      | coefficients from cross-section data.                                   |
|              |                                     |   |
|              |                                     |   |
| ASSESSMENT ( | F CAPABILITIES:                     | A thoroughly tested code used by many laboratories.                     |
| Useful for   | meanelectron en                     | nergy from about twice thermal up to values at                          |
|              |                                     | zation is about 10% of input. Thoroughly documented.                    |
|              |                                     |   |
| ASSESSMENT C | F LIMITATIONS: NO                   | ot accurate when inelastic cross-sections are comparable                |
| with elast   |                                     | n or when energy input to ionization is comparable                      |
| with total   | input.                              |   |
|              |                                     |   |
| OTHER UNIQUI | E FEATURES:                         |   |
|              |                                     |   |
|              |                                     |   |
| ORIGINATOR/E | EY CONTACT:                         |   |
|              | A. V. Phelps                        |   |
|              |                                     | itute for Laboratory Astrophysics                                       |
| Address:     | U. of Colorado                      | o, Boulder, CO 80309  |
| Phone:       | (303) 492-7850                      |   |
|              | OCUMENTATION (Pleated Publication): | ease specify, use $T$ = Theory, $U$ = User's Manual, $L$ = Listing, and |
|              |                                     | nd A.V. Phelps, Phys. Rev. 127, 1621 (1962)                             |
|              |                                     | . Math. Analysis and Applications 1, 342 (1960).                        |
| L, U - P.    |                                     | nformation Center Report No. 14, Oct. 30 (1975)                         |
|              |                                     |   |
|              |                                     |   |
| STATUS:      |                                     |   |
|              | al Currently?; X                    |   |
| Under Mo     | dification?:                        |   |
| Purp         | ose(s): Some mod1:                  | fications have been made since Luft's report.                           |
|              |                                     |   |
|              |                                     |   |
|              | p?:                                 |   |
| Proprieta    |                                     | which installed): CDC 7600 & CDC 6400                                   |
| MACHINE/ OPE | KATING SISTEM (OF                   | which installed):   |
| TRANSPORTA   | BLE?: X                             |   |
|              |                                     | 16;   |
|              |                                     |   |
| SELF-CONTAIN | NED?:                               |   |
| Other Co     | des Required (name, p               | purpose): None  |
|              |                                     |   |
| ESTIMATE OF  | RESOURCES REQUIR                    | RED FOR RUNS:   |
|              | Core Size (Octa                     | 1 Words) Execution Time (sec, CDC 7600)                                 |
| Small Job    |                                     |   |
| Typical J    |                                     | 1000  |
| Large Jo     |                                     | BANK AND                            |
|              |                                     | RAN Lines:  |
| COMMENTS: _  |                                     |   |
|              |                                     |   |

## KINETICS CODE

|   | CODE NAME:  |
|---|---|
| 1. CODE STRUCTURE                         | 3. LASING KINETICS MODEL                              |
| COORDINATE SYSTEM (♥): NA                 | GENERAL (specify):                                    |
| Cartesian: Expanding:                     | Lasing Species: 0                                     |
| KINETICS GRID DIMENSIONALITY (1):         | Number of Species: 1 electrons                        |
| 1-D: 2-D: Uniform                         | Number of Reactions:                                  |
| 3-D: Onliorm                              | Other Major Species Considered;                       |
| GAIN REGION SYMMETRY RESTRICTIONS: NA     | Other Major Species Considered;                       |
| Gain Vary Along Optical Axis:             |   |
| Flow Direction:                           | IMPACT EXCITATION MODELED (√):                        |
| KINETICS MODELED: Pulsed: CW:             | (Reference)   |
| NUMERICAL SCHEME USED IN RATE             | Vibrational:  |
| CALCULATION ( ):                          | Electronic:   |
| Explicit:                                 | Others (specify): rotation                            |
| Implicit:                                 | Control (operator)                                    |
| Gthers (specify): backward prolongation   | ENERGY TRANSFER MODES MODELED ( ):                    |
|   | (Reference)   |
|   | V-T:1 NA  |
| REFERENCE OF METHOD USED:                 | V-R:  |
| Sherman                                   | V-V:  |
|   | Others (specify):                                     |
| 2. PLASMA KINETICS MODEL                  | Lasing Transition: P-Branch:                          |
| NUMBER OF SPECIES TREATED (specify):      | R-Branch:   |
| Number of Positive                        | Single Line Model (√):                                |
| Number of Norotine                        | Multi-Line Model (√):                                 |
| Species:                                  | Assumed Rotational Population Distribution State ( ): |
| Number of Neutral Species:                | Equilibrium:  |
| REACTION MECHANISM MODELED (√):           | Nonequilibrium;                                       |
| Primary Ionization: (Reference)           | Number of Laser Lines                                 |
| E-Beam;                                   | Modeled:  |
| Self-Sustained:                           | Source of Rate Coefficients Used in Code:             |
| UV-Initiated:                             |   |
| Others (specify):                         |   |
|   | LINE PROFILE MODELS ( ):                              |
| Secondary Ionization (Reference)          | Doppler Broadening: NA                                |
| Attachment;                               | Collisional Broadening:                               |
| Detachment:                               | Others (specify):                                     |
| lon-Ion Recom-                            | <del></del>   |
| bination;                                 | 4. RECIRCULATION CONTAMINANTS                         |
| Charge Transfer:                          | MODELED (√): NA                                       |
| Dissociation/<br>Recombination:           | O <sub>x</sub> :OH <sub>x</sub> :                     |
| Others (specify):                         | NO <sub>x</sub> : HNO <sub>x</sub> :                  |
|   | Others (specify):                                     |
| Source of Rate Coefficients Used: Varying |   |
|   | REFERENCE FOR REACTION MECHANISM                      |
| DISCHARGE POWER INPUT MODELED ( ):        | AND RATES:  |
| Uniform; Non-Uniform;                     | OTHER INTOINE PROPERTY.                               |
| E-Field;                                  | OTHER UNIQUE FEATURES:                                |
| Others (specify):                         |   |
|   |   |
|   |   |

| CODE NAME: BI    |  | CHNICAL AREA(S): Kinetics   |
|------------------|--|---|
| DEVICE COMPONE   | NTS TREATED: Laser                           | Cavity  |
|                  |  | CODE: To model the laser kinetics of a  |
|                  |  | d to predict the performance of the laser.  |
|                  | Δ  |   |
|                  |  |   |
| ACCRECATING OF C | ADARY ITIES Can handle                       | e gas mixtures of CO <sub>2</sub> : N <sub>2</sub> : He: H <sub>2</sub> O: H <sub>2</sub> |
| at any temper    | ature and pressure. at                       | nd for any pulse length.  |
| at any temper    | acure and pressure, as                       | and for any parce rendered  |
|                  |  |   |
| ASSESSMENT OF L  | IMITATIONS: Is one-d                         | imensional, stable resonators, and assumes  |
| that the rota    | tional and kinetic ter                       | mperatures are the same.  |
|                  |  |   |
| OTHER UNIQUE FE  | ATURES: The lowest                           | eight vibrational levels are treated exactl   |
| and the popul    | ation of the rotation                        | al level involved in the lasing is not  |
| assumed to be    | in equilibrium with                          | the other rotational level populations.   |
|                  |  |   |
| ORIGINATOR/KEY   |  |   |
| Name: Ly         | le Taylor                                    | in Company in   |
| Organization:    | Westinghouse Electr<br>1310 Beulah Rd., Pitt | sburgh, PA 15668  |
|                  |  | Spargii, FA 15000   |
|                  | 12-327-5833                                  |   |
|                  | MENTATION (Please specify, Publication):     | use T = Theory, U = User's Manual, L = Listing, and                                       |
|                  |  | . Feldman, D.R. Suhre, L.H. Taylor, G.L.  |
| Unger, an        | d S.A. Wultzke, "Oper                        | ational Characteristics of 16 mm CO, Laser,   |
| "Westingh        | ouse Report 80-1C2-OC                        | COL-R1 (1980).  |
|                  |  |   |
|                  |  |   |
| STATUS:          |  |   |
| Operational C    | urrently?: Yes                               |   |
|                  | cation?: No                                  |   |
|                  | s):  |   |
|                  |  |   |
|                  |  |   |
| _                | Westinghouse                                 |   |
| Proprietary?     |  |   |
| MACHINE/OPERAT   | TING SYSTEM (on which insta                  | lled): <u>U-1106</u>  |
| TRANSPORTABLE    | ?: Yes                                       |   |
|                  |  | ne  |
| CRI E CONTAINED  | ^  |   |
| SELF-CONTAINED   |  |   |
| Other Codes I    | Required (name, purpose):                    |   |
| ESTIMATE OF RES  | SOURCES REQUIRED FOR RU                      | INS:  |
|                  | Core Size (Octal Words)                      | Execution Time (sec, CDC 7600)  |
| Small Job:       |  |   |
| Typical Job:     | 51400  | 3600 sec, U-1106  |
| Large Job:       |  |   |
|                  | Number of FORTRAN Lines:                     | 2080  |
| COMMENTS:        |  |   |
| Fabry-Perot      | Cavity modeled using g                       | geometric optics and floating gain.   |
|                  |  |   |

## KINETICS CODE

|   | OUSE WANTE. DELLE-SE                                  |
|---|---|
| CODE STRUCTURE                          | 3. LASING KINETICS MODEL                              |
| COORDINATE SYSTEM ( ):                  | GENERAL (specify):                                    |
| Cartesian: Expanding:                   | Lasing Species: CO2                                   |
| KINETICS GRID DIMENSIONALITY (√):       | Number of Species: 5                                  |
| 1-D: 2-D:                               | Number of Reactions: 58                               |
| 3-D:                                    | Other Major Species Considered:                       |
| GAIN REGION SYMMETRY RESTRICTIONS:      | N2, He, H <sub>2</sub> O, H <sub>2</sub>              |
| Gain Vary Along Optical Axis: No        |   |
| Flow Direction: No                      | IMPACT EXCITATION MODELED (√):                        |
| KINETICS MODELED: Pulsed: CW:           | (Reference)   |
| NUMERICAL SCHEME USED IN RATE           | Vibrational:  |
| CALCULATION (√):                        | Electronic:   |
| Explicit;                               | Others (specify):                                     |
| Implicit:                               |   |
| Others (specify): Hamming               | ENERGY TRANSFER MODES MODELED (√):                    |
|   | (Reference)   |
| - Uamping                               | V-T: 1  |
| REFERENCE OF METHOD USED: R.W. Hamming, | V-R: V  |
| Numerical Methods for Engineers and     | V-V: V  |
| Scientists, (1962).                     | Others (specify):                                     |
| PLASMA KINETICS MODEL                   | Lasing Transition: P-Branch:                          |
| NUMBER OF SPECIES TREATED (specify):    | R-Branch:   |
| Number of Positive                      | ,   |
| Species:                                | Single Line Model (♥):  Multi-Line Model (♥):         |
| Number of Negative Species:             |   |
| Number of Neutral<br>Species;           | Assumed Rotational Population Distribution State ( ): |
| REACTION MECHANISM MODELED (√):         | Equilibrium:   Nonequilibrium:                        |
| Primary Ionization: (Reference)         | Number of Laser Lines                                 |
| E-Beam:                                 | Modeled: 4  |
| Self-Sustained;                         | Source of Rate Coefficients Used in Code:             |
| UV-Initiated;                           |   |
| Others (specify):                       |   |
|   | LINE PROFILE MODELS (1):                              |
| Secondary Ionization (Reference)        | Doppler Broadening:                                   |
| Attachment:                             | Collisional Broadening:                               |
| Detachment:                             | Others (specify): Voigt Profiles are us               |
| Ion-Ion Recom-                          |   |
| bination:                               |   |
| Charge Transfer:                        | 4. RECIRCULATION CONTAMINANTS                         |
| Dissociation/                           | MODELED ( <b>√</b> ): none                            |
| Recombination:                          | O <sub>x</sub> : OH <sub>x</sub> :                    |
| Others (specify):                       | NO <sub>x</sub> : HNO <sub>x</sub> :                  |
|   | Others (specify):                                     |
| Source of Rate Coefficients Used:       |   |
|   | REFERENCE FOR REACTION MECHANISM AND RATES:           |
| DISCHARGE POWER INPUT MODELED ( ):      | AND BA - 10.  |
| Uniform; Non-Uniform;                   | OTHER UNIQUE FEATURES:                                |
|   | Carrette Larration Larration                          |
| E-Field:Others (specify);               |   |

| CODE NAME: BO   | LTZ TE                     | CHNICAL AREA(S): Electron Kinetics                  |
|-----------------|----------------------------|---|
| DEVICE COMPONE  | NTS TREATED:Overal         | 1 System Characteristics                            |
|                 |                            | CODE: Given a homogenous isotropic was mixture      |
| with a unifor   | m applied DC field, o      | ode calculated the e distribution function          |
| and thus the    | forward/reverse excit      | ation pumping rates and the fractional power .      |
| transfer for    | each process as well       | as transport proeprties. These rates can be used    |
| in a kinetics   | code to determine th       | e time-varying population distribution.             |
| ASSESSMENT OF C | APABILITIES: Given E/      | N, and a set of cross-sections, BOLTZ calculates    |
| all the above   | quantities. Code ha        | s a variable number of bins for integrating,        |
| can include v   | ariable number of gas      | es, super-elastic and electron-electron collisions. |
|                 |                            |   |
| ASSESSMENT OF L | IMITATIONS: Number of      | energy bins & inelastic processes are limited       |
|                 |                            | el is valid for fractional ionization up to         |
|                 |                            | ization and dissociation ≤10%. Convergence          |
|                 | for superelastic-domi      |   |
| OTHER UNIQUE FE |                            |   |
|                 |                            |   |
|                 |                            |   |
|                 |                            |   |
| ORIGINATOR/KEY  | CONTACT                    |   |
|                 | T Gary L. Duke             |   |
| Organization:   | AFWAL/POOC-3               |   |
| Address Wr      | ight-Patterson AFB, D      | ayton, OH 45433                                     |
|                 | 3) 255-2923                |   |
|                 |                            | use T = Theory, U = User's Manual, L = Listing, and |
| RP = Related    | Publication): Code is we   | ll documented with comment cards (U):               |
| TETRA-TR-       | 78-001."BOLTZ a code       | to solve the BOLTZMANN Electron Transport           |
|                 |                            | tig Bennedict, Jr., William P. Bailey, 1978.        |
| 24              | cp. 1114                   | between definition is builty 1570.                  |
|                 |                            |   |
|                 |                            |   |
|                 |                            |   |
| STATUS:         | 11                         |   |
|                 | urrently?: yes             |   |
| Under Modific   | ation?: NO                 |   |
| Purpose(        | 8):                        |   |
|                 |                            |   |
|                 |                            |   |
| Ownership?;_    | AFWAL/POOC                 |   |
| Proprietary?    | no                         |   |
| MACHINE/OPERAT  | ING SYSTEM (on which insta | Iled): CYBER 175 and CYBER 74                       |
|                 |                            |   |
| TRANSPORTABLE   | Probably                   |   |
| Machine Depe    | ndent Restrictions: Prog   | rammed in Fortran IV                                |
|                 |                            |   |
| SELF-CONTAINED  | ?: yes                     |   |
| Other Codes I   | Required (name, purpose):  | none  |
|                 |                            |   |
| ESTIMATE OF RES | OURCES REQUIRED FOR RI     | INS:  |
|                 | Core Size (Octal Words)    | Execution Time (sec, CDC 7600)                      |
| Small Job:      | 50K                        | 10 sec (10 diff E/N's input)                        |
| Typical Job:    | 100K                       | 20 sec (10 diff E/N's input)                        |
|                 | 150K                       | 9 sec (3 diff E/N's input)                          |
| Large Job:      |                            | 500   |
|                 | Number of FORTRAN Lines:   |   |
|                 |                            | ron kinetics code, not a gas kinetics code.         |
| AS YET IT IS N  | or rinked to any other     | r kinetic or chemistry type code.                   |

## KINETICS CODE

I. CODE STRUCTURE

CODE NAME: BOLTZ

3. LASING KINETICS MODEL
GENERAL (specify):

| COORDINATE SYSTEM (√):   | GENERAL (specify):  |  |  |  |  |
|--|---|--|--|--|--|
| Cartesian: Expanding:  | Lasing Species:   |  |  |  |  |
| KINETICS GRID DIMENSIONALITY (√):                                      | Number of Species:  Number of Reactions:                              |  |  |  |  |
| 1-D: <u>/</u> 2-D:   |   |  |  |  |  |
| 3-D:   | Other Major Species Considered: Rotational,                           |  |  |  |  |
| GAIN REGION SYMMETRY RESTRICTIONS:                                     | attachment, dissociation, ionization                                  |  |  |  |  |
| Gain Vary Along Optical Axis:  | (all empact)  |  |  |  |  |
| Flow Direction:  | IMPACT EXCITATION MODELED (♥):  |  |  |  |  |
| KINETICS MODELED: Pulsed: V CW: V                                      | (Reference)   |  |  |  |  |
| NUMERICAL SCHEME USED IN RATE CALCULATION (√):                         | Vibrational:  |  |  |  |  |
| Explicit:  | Others (specify):   |  |  |  |  |
| Implicit:  | Others (spectry):   |  |  |  |  |
| Others (specify):  | ENERGY TRANSFER MODES MODELED ( <b>√</b> ): (Reference)               |  |  |  |  |
| REFERENCE OF METHOD USED: Simpson                                      | V-T:  |  |  |  |  |
| Integration  | V-R:  |  |  |  |  |
|  | V-V:  |  |  |  |  |
| 2. PLASMA KINETICS MODEL   | Others (specify):   |  |  |  |  |
| NUMBER OF SPECIES TREATED (specify):                                   | Lasing Transition: P-Branch:  |  |  |  |  |
| Number of Positive   | R-Branch:   |  |  |  |  |
| Species:   | Single Line Model (√):  |  |  |  |  |
| Number of Negative   | Multi-Line Model (√):   |  |  |  |  |
| Species: <u>electrons</u> only  Number of Neutral  Species: any number | Assumed Rotational Population Distribution State $\{\sqrt{\cdot}\}$ : |  |  |  |  |
|  | Equilibrium:  |  |  |  |  |
| REACTION MECHANISM MODELED (1):  | Nonequilibrium:   |  |  |  |  |
| Primary Ionization: (Reference)  E-Beam:                               | Number of Laser Lines<br>Modeled:                                     |  |  |  |  |
| Self-Sustained:  | Source of Rate Coefficients Used in Code:                             |  |  |  |  |
| UV-Initiated:  |   |  |  |  |  |
| Others (specify):  |   |  |  |  |  |
|  | LINE PROFILE MODELS ( ):  |  |  |  |  |
| Secondary Ionization (Reference)                                       | Doppler Broadening:   |  |  |  |  |
| Attachment:  | Collisional Broadening:   |  |  |  |  |
| Detachment;  | Others (specify):   |  |  |  |  |
| Ion-Ion Recom-<br>bination:  |   |  |  |  |  |
| Charge Transfer:   | 4. RECIRCULATION CONTAMINANTS MODELED (√): none                       |  |  |  |  |
| Dissociation/  | 1   |  |  |  |  |
| Recombination:   | O <sub>X</sub> : OH <sub>X</sub> :                                    |  |  |  |  |
| Others (*pecify):  | NO <sub>x</sub> : HNO <sub>x</sub> :                                  |  |  |  |  |
|  | Others (specify):   |  |  |  |  |
| Source of Rate Coefficients Used:                                      | REFERENCE FOR REACTION MECHANISM                                      |  |  |  |  |
| DISCHARGE POWER INPUT MODELED ( ):                                     | AND RATES:  |  |  |  |  |
| Uniform: Non-Uniform:  | OTHER UNIQUE FEATURES:  |  |  |  |  |
| E-Field: VE/N input  | OTHER ORIGOD PERFORES;  |  |  |  |  |
| Others (specify):  |   |  |  |  |  |

| CODE N   | AME:_   | CCUBE               |            |         | TE           | CHNICA   | LAREA     | (S):   | Gas Dynamics                  |                   |
|----------|---------|---------------------|------------|---------|--------------|----------|-----------|--------|-------------------------------|-------------------|
|          |         |                     |            |         |              |          |           |        | Exchangers, Compress          | ior               |
| PRINCIP  | PAL P   | UR POSE(S           | )/APPLIC   | CATION  | (S) OF       | CODE:    | Comp      | utes   | the flow properties           | throughout        |
| a cl     | osed    | circula             | tor for    | as      | teady        | state    | cw las    | er.    |                               |                   |
|          |         |                     |            |         |              |          |           |        |                               |                   |
|          |         |                     |            |         |              |          |           |        |                               |                   |
| ASSESSI  | MENT    | OF CAPA             | BILITIES   | Tem     | perati       | ire de   | pendent   | gas    | properties are model          | ed.               |
| ASSESSI  | MENT    | OF LIMIT            | ATIONS:    |         |              |          |           |        |                               |                   |
| OTHER    | UNIQU   | JE FEATU            | RES: C     | an be   | used         | to in    | vestiqa   | ite v  | arious design configu         | rations.          |
|          |         |                     |            |         |              |          |           |        |                               |                   |
|          |         | KEY CON             |            | a       | C ch         | i h      |           |        |                               |                   |
| Na<br>Or | ame:    | G. R. F             | ech. En    | g. De   | pt.,         | Univ.    | of Ala.   | in     | Huntsville                    | <del></del>       |
|          | -       | Hunts               |            |         |              |          |           |        |                               |                   |
|          |         |                     |            |         |              |          | 75, or    | (205)  | 895-6145                      |                   |
| AVAILA   | BLE     | OCUMEN'             | TATION (   | Please  | specif       | y, use T | = Theory  | (, U = | User's Manual, L = Listing, a | and<br>Percet 164 |
|          |         | h, Karr             |            |         |              |          | er Gas    | CITC   | ulation Systems, UAH          | Report 104,       |
| Shih     | n & K   | arr, In             | vestiga    | tion    | of Tr        | ansien   | t Flow    | and    | Heating Problems Char         | acteristic        |
| of I     | ligh :  | Energy 1            | Laser C    | ircul   | ation        | Syste    | ms, UAI   | i, Re  | port No. 199, 1977.           |                   |
|          |         |                     |            |         |              |          |           |        |                               |                   |
| _        |         |                     |            |         |              |          |           |        |                               |                   |
| STATUS   |         |                     |            |         |              |          |           |        |                               |                   |
|          |         | nal Curre           |            |         |              |          |           |        |                               |                   |
| Ur       |         | odification         |            |         | <u>chang</u> | ina aa   | do uco    | 1 +0   | investigate designs o         | f current         |
|          |         | pose(s):<br>terest. |            | uous    | chang        | ing co   | de used   | 1 10   | investigate designs o         | T current         |
|          |         | ccrese.             |            |         |              |          |           |        |                               |                   |
| Ov       | wnersh  | ip?: [              | JAH        |         |              |          |           |        |                               |                   |
|          |         | ary?:               |            |         |              |          |           |        |                               |                   |
| MACHIN   | NE/OP   | ERATING             | SYSTEM     | (on whi | ich inst     | alled):_ | INU       | VAC 1  | 108                           |                   |
|          |         |                     | Vec        |         |              |          |           |        |                               |                   |
|          |         |                     | yes        |         | no           | ne       |           |        |                               |                   |
| M        | achine  | Dependen            | t Restrict | ions:_  |              |          |           |        |                               |                   |
| SELF-C   | ONTAI   | NED?:               |            |         |              |          |           |        |                               |                   |
|          |         | odes Requi          | red (nam   | e, purp | ose):        | none     | )<br>     |        |                               |                   |
| ESTIMA   | TE OF   | RESOUR              | CES REO    | UIRED   | FOR R        | UNS.     |           |        |                               |                   |
|          |         |                     | e Size (O  |         |              |          | ution Tir | ne (se | c, CDC 7600)                  |                   |
| Sr       | nall Jo |                     |            |         |              | 7        |           |        |                               |                   |
| T        | ypical  | Job:                |            |         |              | } 0      | rder o    | £ 100  | sec.                          |                   |
| La       | arge Jo | ob:                 |            |         |              | 1        |           | 3 -    |                               |                   |
|          |         | mate Num!           |            | RTRAN   | Lines        | - 1 1    | ox car    | us     |                               |                   |
| COMME    | INTS:   |                     |            |         |              |          |           |        |                               |                   |
|          |         |                     |            |         |              |          |           |        |                               |                   |

### GAS DYNAMICS CODE

CCUBE

|   | CODE NAME: CCUBE   |
|---|--|
| CORP. CTRUCTURE   | DECONTACIONA NECESARIO DE LA CARRA DEL CARRA DE LA CARRA DEL CARRA DE LA CARRA |
| . CODE STRUCTURE  | DECONTAMINATION METHOD TREATED (V):  |
| COORDINATE SYSTEM (1):  Cartesian:  | Scrubber:  |
|   | Shower:  |
| FLUID GRID DIMENSIONALITY (V):  | Catalytic Reactor:   |
| I-D:  | Others (specify):  |
| 2-D:  |  |
| 3-D:  |  |
| Time Dependent:   |  |
| FLOW FIELD MODELED (♥):   | 4. ACOUSTIC ATTENUATION MODEL  |
| Compressible Flow:  | GENERAL FEATURES MODELED (√):  |
| Incompressible:   | Single Pulse: Repetitive Pulse:  |
| Viscous Flow:   | DIMENSIONALITY TREATED ( ):  |
| No Flow:  | 1-D: 2-D: 3-D:   |
| BASIC MODELING APPROACH (♥):  | Time-Dependent:  |
| Algebraic: V Integral Method:   | DISTURBANCE MODELED (♥):   |
| Finite Difference:  | Pressure Wave: Entropy Wave:   |
| Others (specify);   | Others (specify):  |
| REFERENCE FOR APPROACH USED:  | WAVE PROPAGATION TREATMENT (√):  |
|   | Linear Wave:   |
|   | Nonlinear Wave:  |
|   | Others (specify):  |
| GAS DYNAMICS MODEL FEATURES:  |  |
| GAS SUPPLY MODELED ( ):   | THEORETICAL BASIS: (Reference)   |
| Mixture Preparation:  | THEORETONE BASE, (Reservice)   |
| Mixture Injection:  |  |
| Nozzles:  | NUMERICAL METHODOLOGY: (Reference)   |
| Flow Plates:  | MOMERICAL METHODOLOGI: (Reference)   |
| Others (specify):   |  |
| Odder (Specify).  | ACQUETIC ATTENUATORS CONSIDERED ( )  |
| CAVITY INITIAL CONDITION DETERMINED   | ACOUSTIC ATTENUATORS CONSIDERED (√):   |
| CAVITY INITIAL CONDITION DETERMINED BY (specify): Calculated as steady State. | Muffler: Heat Exchanger:   |
|   | Horn: Porous Wall:   |
|   | Others (specify):  |
| EXHAUST RECIRCULATION MODEL GENERAL SYSTEM MODELED (√):                       |  |
| · · · · · · · · · · · · · · · · · · ·   | 5. MODEL EFFECTS ON OPTICAL MODES DUE  |
| Open System: Closed System:   | TO ( <b>√</b> ):   |
| Closed Cycle:   | Index of Refraction Variation?:  |
| EXHAUST SYSTEM FEATURES (√):  | Other (specify):   |
| Pressure Recovery:  |  |
| Ejector System:   |  |
| Compressor/Fan:   |  |
| Heat Exchanger:   | OTHER UNIQUE FEATURES:   |
| Gas Make-Up:  |  |
| Others (specuy):  |  |
|   |  |
|   |  |
|   |  |
|   |  |
|   |  |
|   |  |

| CODE  | NAME:      | COLASE                           | TE                     | ECHNICAL AREA(S): Kinetics  |
|-------|------------|----------------------------------|------------------------|---|
|       |            | NENTS TREATED:                   |                        |   |
|       |            |                                  |                        | CODE: To model the laser kinetics of a  |
| puls  | ed, ele    | ctric discharg                   | e CO lase              | er and to predict the performance of the  |
| lase  | r. Thi     | s code is a mo                   | dification             | on of the code developed for CW lasers by   |
| Will  | iam B.     | Lacina of the                    | Northrop               | Corporation.  |
|       |            |                                  |                        |   |
| ASSES | SMENT O    | F CAPABILITIES:_                 | Can hand               | dle gas mixtures of CO: N <sub>2</sub> : Ar: He: Xe: O <sub>2</sub>               |
| at a  | ny temp    | erature and pr                   | essure ar              | nd excited by an electric discharge.  |
|       |            |                                  |                        |   |
|       |            |                                  |                        | is one-dimensional, can only model stable   |
| resc  | nators,    | and assumes t                    | he same t              | temperature for rotational and kinetic  |
| ener  | gies.      |                                  |                        |   |
| OTHE  | P UNIOUE   | FFATURES. In                     | cludes c               | uporelactic collicions and discharge kinetic                                      |
|       |            | histicated out                   |                        | uperelastic collisions and discharge kinetic                                      |
| and   | nas soj    | miscica ced out                  | puc roume              |   |
|       |            |                                  |                        | •   |
| ORIGI | NATOR/K    | EY CONTACT:                      |                        |   |
|       |            | yle Taylor                       |                        |   |
|       |            |                                  | use Elect              | tric Corporation  |
|       |            | 1310 Beulah F                    |                        |   |
|       | _          | 112-256-5833                     |                        |   |
|       |            | CUMENTATION (P                   | lease specify          | y, use T = Theory, U = User's Manual, L = Listing, and                            |
|       |            |                                  | re. L.H.               | Taylor, L.E. Kline, R.R. Mitchell and M.J.  |
|       |            |                                  |                        | O Electric Laser Research", Westinghouse  |
|       | Report     | 77-9C2-COLAS-F                   | 2 (1977)               | •   |
| U: _  | L.H. Ta    | ylor and R.R.<br>er Kinetics Cod | Mitchell<br>le, "West: | " User's Manual for an Electric Discharge inghouse Report 77-9C2-COLAS-R1 (1977). |
| STATU |            |                                  |                        |   |
|       |            | al Currently?: no                |                        |   |
|       |            | diffication?; no                 |                        |   |
| '     |            | se(s):                           |                        |   |
|       | 1 di pa    |                                  |                        |   |
|       |            |                                  |                        |   |
| (     | Ownership  | ?: U. S. Gover                   | nment_                 |   |
| 1     | Proprieta  | ry?: no                          |                        |   |
| MACH  | INE/OPE    | RATING SYSTEM (o                 | n which inst           | talled): U-1106 and CDC-7600  |
|       |            |                                  |                        |   |
|       | SPORTAB    |                                  |                        |   |
| 1     | Machine [  | ependent Restrictio              | ns:                    |   |
| SELF- | CONTAIN    | ED?: Yes                         |                        |   |
|       |            | es Required (name,               | purpose).              |   |
|       |            |                                  |                        |   |
| ESTIM | ATE OF     | RESOURCES REQUI                  | RED FOR R              | UNS:  |
|       |            | Core Size (Oct                   | al Words)              | Execution Time (sec, CDC 7600)  |
| 9     | small Job  |                                  |                        |   |
|       | Typical Jo | b: 340,000                       |                        | 60 sec, CDC-7600  |
|       | Large Job  | :                                |                        |   |
|       | Approxim   | ate Number of FOR                | TRAN Lines:            | . 6878  |
| сомм  | ENTS: _    |                                  |                        |   |
| Fal   | bry-Per    | ot cavity mode                   | l using f              | loating gain, geometric optics.   |

CODE NAME: COLASE

| 1. CODE STRUCTURE                              | 3. LASING KINETICS MODEL   |
|--|--|
| COORDINATE SYSTEM (√):                         | GENERAL (specify):   |
| Cartesian: V Expanding:                        | Lasing Species:CO  |
| KINETICS GRID DIMENSIONALITY ( ):              | Number of Species: 6   |
| 1-D:   | Number of Reactions: 10  |
| 3-D:   | Other Major Species Considered:  |
| GAIN REGION SYMMETRY RESTRICTIONS:             | N <sub>2</sub> , Ar, He, Xe, O <sub>2</sub>                                |
|  | 10, AI, He, Ae, O2   |
| Gain Vary Along Optical Axis: <u>no</u>        |  |
| Flow Direction: no                             | IMPACT EXCITATION MODELED (♥):   |
| KINETICS MODELED: Pulsed: V CW:                | (Reference)  |
| NUMERICAL SCHEME USED IN RATE CALCULATION (√): | Vibrational:   |
| Explicit:                                      | Electronic:  |
| Implicit:                                      | Others (specify):  |
| Others (specify): Simpson's Rule               |  |
| Others (specify): Dimpsoil S Rule              | ENERGY TRANSFER MODES MODELED (√):   |
|  | (Reference)  |
|  | V-T:   |
| REFERENCE OF METHOD USED:                      | V-R:   |
|  |  |
|  | Others (specify):  |
| 2. PLASMA KINETICS MODEL                       | Lasing Transition: P-Branch:   |
| NUMBER OF SPECIES TREATED (specify):           | R-Branch:  |
| Number of Positive                             |  |
| Species: 6                                     | Single Line Model (√):   |
| Number of Negative 6                           | Multi-Line Model (√):  |
| Species:                                       | Assumed Rotational Population Distribution State ( $\sqrt{}$ ):            |
| Number of Neutral 6 Species:                   | Equifibrium:   |
| REACTION MECHANISM MODELED (♥):                |  |
| Primary ionization: (Reference)                | Nonequilibrium:  |
| FBeam;   | Modeled: 40  |
|  | Source of Rate Coefficients Used in Code:                                  |
| Self-Sustained:                                |  |
| UV-initiated:                                  |  |
| Others (specify):                              | LINE PROFILE MODELS ( ):   |
|  |  |
| Secondary Ionization (Reference)               | Doppier Broadening:  |
| Attachment:                                    | Collisional Broadening:  |
| Detachment:                                    | Others (specify):  |
| Ion-Ion Recom-                                 |  |
| bination;                                      | A DECIDENT A TION CONTAMINANTE   |
| Charge Transfer:                               | 4. RECIRCULATION CONTAMINANTS  MODELED (√): None                           |
| Dissociation/                                  | · · · · · · · · · · · · · · · · · · ·                                      |
| Recombination:                                 | O <sub>X</sub> : OH <sub>X</sub> :<br>NO <sub>X</sub> : HNO <sub>X</sub> : |
| Others (specify):                              | Others (specify):  |
|  | Others (specify):  |
| Source of Rate Coefficients Used:              |  |
|  | REFERENCE FOR REACTION MECHANISM AND RATES:                                |
| DISCHARGE POWER INPUT MODELED ( 1:             | 410.000  |
| Uniform: V Non-Uniform;                        | OTHER UNIQUE FEATURES.   |
| E-Field:                                       | OTHER UNIQUE FEATURES:   |
| Others (specify):                              |  |
|  |  |
|  |  |

| CODE NAME: DENS                | ITY TEC  | HNICAL AREA(S):                        | Kinetics   |
|--------------------------------|--|--|--|
|                                | IS TREATED: None, ot   |  |  |
| PRINCIPAL PURPOSI              | E(S)/APPLICATION(S) OF C                                     | ODE: Determine                         | the time dependent species plasma. Program is centered                                       |
| around a subrou                | tine DGEAR from the  | International M                        | athematics and Science Library   |
|                                |  |  | ine for solving stiff differentia  |
| equations.                     |  |  |  |
| Requires 110K                  | of storage, 32K of w   | hich is a plott                        | es, plus voltage and current. ing routine. It takes ~7 sec. t s upon how stiff the equations |
| are.                           | .ine increments. Ini   | s really depend                        | s upon now still the equations   |
| are.                           |  |  |  |
|                                |  |  | to change the number of  |
| equations. Cod                 | le requires data bank  | of rates.                              |  |
|                                |  |  |  |
|                                | m) - 1 - A   | 12 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 |  |
| separate code o                | TURES: The electron called BOLTZ which is sing a SPLINE fit. | not yet linked                         | re generally calculated by a to DENSITY. These rates are                                     |
| - Interpolated di              | Ting a SPEINE TIC.   |  |  |
|                                | •  |  |  |
| ORIGINATOR/KEY CO              |  |  |  |
| Name: CPT                      | Gary L. Duke   |  |  |
| Organization:                  | AFWAL/POOC-3   |  |  |
| Add. cos.                      | ght-Patterson AFB, C   |  |  |
| Phone: (513)                   | 255-2923 or (513) 25   | 5-3835                                 |  |
| RP = Related Po                | ENTATION (Please specify None on D                           | use T = Theory, U =<br>ensity          | User's Manual, L = Listing, and  |
|                                | scribed in the IMSL  |  |  |
|                                |  |  | al Equation System Solver,"  |
|                                | vermore Lab. Report  |  |  |
|                                | C.W. Numerical Initia<br>all, Engelwood Cliffs               |  | s in Ordinary Differential Eqs,<br>971.  |
| STATUS:                        |  |  |  |
| Operational Cur                | rently?: ves   |  |  |
| Under Modificat                |  |  |  |
|                                |  | mber of species                        | , update rates, and link to BOLT   |
|                                |  |  | riable time step dependent   |
|                                | oltage change.   |  |  |
| Ownership?:                    | U.S. Government  |  |  |
| Proprietary?:                  |  |  |  |
|                                | G SYSTEM (on which instal                                    | ledy CDC 6600 ;                        | - PODTRAN  |
| MACHINE/OFERATI                | O 3 13 1EM (OII WILLII III III                               | .eu):                                  | II FORTRAN   |
| TDANSDOD TABLES.               | yes, if IMSL is ava  | ilable                                 |  |
|                                |  |  |  |
| Machine Depend                 | lent Restrictions:   |  |  |
| - CONTAINED                    |  |  |  |
| SELF-CONTAINED?:               | -,-,-,   | DGEAR involves                         | still differntial equations.   |
| Other Codes Re                 | quired (name, purpose):                                      |  |  |
|                                |  |  |  |
|                                | URCES REQUIRED FOR RUI                                       |  |  |
|                                | Core Size (Octal Words)                                      | Execution Time (see                    | c, CDC 7600)   |
|                                | 110K   | 3 sec                                  |  |
| Small Job:                     | 110K   | 7 sec (500 tim                         | e increments)  |
| Small Job: _<br>Typical Job: _ |  |  |  |
|                                | 110K   | 20 sec                                 | ****   |
| Typical Job:<br>Large Job:     | 110K umber of FORTRAN Lines:                                 | 450 excluding D                        | GEAR   |
| Typical Job:<br>Large Job:     |  |  | GEAR   |

CODE NAME: DENSITY 1. CODE STRUCTURE 3. LASING KINETICS MODEL COORDINATE SYSTEM (√): GENERAL (specify): Cartesian: V\_\_ Expanding:\_ Lasing Species: XeCl KINETICS GRID DIMENSIONALITY (1): Number of Species: 1 1-D: V 2-D: Number of Reactions: 2 3-D: Other Major Species Considered: GAIN REGION SYMMETRY RESTRICTIONS:  $Xe^*$ ,  $Xe^+$ ,  $Xe_2$ , Cl, HCl  $(-\nu=1)$ Gain Vary Along Optical Axis: Flow Direction: IMPACT EXCITATION MODELED ( ): KINETICS MODELED: Pulsed: V CW: (Reference) NUMERICAL SCHEME USED IN RATE VI HC1 Vibrational: CALCULATION ( ): Electronic: Explicit: Others (specify): Implicit: DGEAR Others (specify): ENERGY TRANSFER MODES MODELED (1): (Reference) V-I: ✓ | Collisional relaxation rate See description REFERENCE OF METHOD USED: in Available Documentation V - V: Others (specify):\_ 2. PLASMA KINETICS MODEL Lasing Transition: P-Branch: NUMBER OF SPECIES TREATED (specify); R-Branch: Number of Positive Single Line Model (√): Species: Multi-Line Model (√): Number of Negative Assumed Rotational Population Species: Distribution State ( 1: Number of Neutral Species: Equilibrium: REACTION MECHANISM MODELED (1): Nonequilibrium: Primary Ionization: (Reference) Number of Laser Lines Modeled: E-Beam: only Townsend ionization Source of Rate Coefficients Used in Code. Self-Sustained: > UV-Initiated: Others (specify): LINE PROFILE MODELS ( ): Doppler Broadening: Secondary Ionization (Reference) Collisional Broadening: Attachment: Others (specify): Detachment: Ion-Ion Recombination: 4. RECIRCULATION CONTAMINANTS Charge Transfer: MODELED (√): none Dissociation/ Ox: OHx: Recombination: NO : HNO : Others (specify): Others (specify): Source of Rate Coefficients Used: REFERENCE FOR REACTION MECHANISM Current literature AND RATES: DISCHARGE POWER INPUT MODELED (V): Uniform; Non-Uniform; OTHER UNIQUE FEATURES: E-Field: Others (specify): LRC circuit

|  |   | CHNICAL AREA(S): Kinetics  |
|--|---|--|
| DEVICE COMPONENT   | TS TREATED: Dischar                     | ge gap including the foil, cathode, and the anode                            |
| PRINCIPAL PURPOS   | E(S)/APPLICATION(S) OF                  | CODE: The code is developed to model the E-beam                              |
|  |   | of an EDL under prescribed E-field and B-field.                              |
| It computes the  | E-beam energy depo                      | sition distribution. When it is coupled to the                               |
| PLASMA TRANSPOR  | RT CODE, accurate E-                    | field and ionization distributions can be obtained.                          |
|  |   |  |
| ASSESSMENT OF CA   | PABILITIES: Although                    | this code was written for the beam-electron                                  |
| energies betwee  | en 5 to 500 keV, the                    | e energy range can be extended by adding more                                |
|  | s and changing the o                    | cross sections. Discharge geometry can also                                  |
| be altered.  |   |  |
| ASSESSMENT OF LIN  | MITATIONS: At the pre                   | esent time, discharge cavities with dielectric                               |
|  |   | ot be handled; field penetration in the region                               |
| between the foi  | il and the cathode :                    | is ignored.  |
|  |   |  |
| OTHER UNIQUE FEA   | TURES: Semi-analytic                    | cal and semi-empirical formulas will be used to                              |
|  |   | ion will be made for estimating the space                                    |
| charge arising   | from thermalization                     | n of the backscattered E-beam  |
|  |   |  |
| ORIGINATOR/KEY C   | ONTACT:                                 |  |
| Name: T.K.   | Tio                                     |  |
| Organization:  | P & D Associated                        |  |
|  | . Box 9695, Marina                      |  |
| Phone: (213)   | 822-1715 ext. 448                       |  |
| AVAILABLE DOCUM  | ENTATION (Please specif                 | y, use T = Theory, U = User's Manual, L = Listing, and                       |
| _  | ublication): Permission                 | from AFWL is required to obtain the following                                |
| documents.   | N 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 | (m)  |
| I. EDL Disc  | charge Modeling Sta                     | Transport (T)  |
| 2. LASL MOI  | nte-Carlo Electron                      | Fransport Codes, Pts. I & II (Flow Charts) Electron Transport Codes (U,L)    |
| 3. Using th  | ne LASL Monte-Carlo                     | Election Transport Codes (0,1)   |
|  |   |  |
| STATUS:  |   |  |
|  | rrently?: not ready                     |  |
| Under Modifica   | tion?: yes                              | ade by incorporating comi-analytic and                                       |
| Purpose(s)   | i to speed up the co                    | ode by incorporating semi-analytic and sample the space charges arising from |
|  |   | Sample the space charges all sing from                                       |
| the bac  | kscattered E-beam.                      |  |
| Ownership?:  | RDA                                     |  |
| Proprietary?:_   | Permission from AF                      | wL is required.  |
| MACHINE/OPERATII   | NG SYSTEM (on which inst                | alled): CRAY-1   |
|  | · · · · · · · · · · · · · · · · · · ·   |  |
| TRANSPORTABLE?:  |   |  |
| Machine Depend   | ient Restrictions: <u>Core</u>          | size, FORTRAN Lanquage   |
|  |   |  |
| SELF-CONTAINED?  |   | Poisson equation solver is required to iterate                               |
| Other Codes Re   | equired (name, purpose):<br>E-field.    | Totason equation solver is required to rectate                               |
|  |   |  |
|  | URCES REQUIRED FOR R                    |  |
|  | Core Size (Octal Words)                 |  |
| Small Job:   | 200,000                                 | 250 (for 1,000 particles)  |
| Typical Job:   | 200,000                                 | 1,250 (for 5,000 particles) 2,500 (for 10,000 particles)                     |
| Large Job:   | 200,000                                 | 12 000   |
| The second secon | umber of FORTRAN Lines                  | 22,000   |
| COMMENTS:  |   |  |
|  |   |  |

CODE NAME: E-Beam Transport

| l. CODE STRUCTURE                    | 3. LASING KINETICS MODEL                  |
|--------------------------------------|---|
| COORDINATE SYSTEM ( ):               | GENERAL (specify):                        |
| Cartesian; X Expanding:              | Lasing Species:                           |
| KINETICS GRID DIMENSIONALITY (1):    | Number of Species:                        |
| 1-D: 2-D:                            | Number of Reactions:                      |
| 3-D:                                 | Other Major Species Considered:           |
| GAIN REGION SYMMETRY RESTRICTIONS:   | Other Major Species Considered:           |
| Gain Var. Along Optical Axis:        |   |
| Flow Direction:                      | IMPACT EXCITATION MODELED ( ):            |
| KINETICS MODELED: Pulsed: CW:        |   |
| NUMERICAL SCHEME USED IN RATE        | (Reference) Vibrational:                  |
| CALCULATION / 1:                     |   |
| Explicit:                            | Electronic:                               |
| Implicit:                            | Others (specify):                         |
| Others (specify):                    |   |
|                                      | ENERGY TRANSFER MODES MODELED ( ):        |
|                                      | (Reference)                               |
| REFERENCE OF METHOD USED:            | V-T:                                      |
|                                      | V-R:                                      |
|                                      | V-V:                                      |
| . PLASMA KINETICS MODEL              | Others (specify):                         |
| NUMBER OF SPECIES TREATED (specify): | Lasing Transition: P-Branch:              |
| Number of Positive                   | R-Branch;                                 |
| Species:                             | Single Line Model (√):                    |
| Number of Negative                   | Multi-Line Model (√):                     |
| Species:                             | Assumed Rotational Population             |
| Number of Neutral                    | Distribution State ( $$ ):                |
| Species:                             | Equilibrium:                              |
| REACTION MECHANISM MODELED (√):      | Nonequilibrium:                           |
| Primary Ionization: (Reference)      | Number of Laser Lines Modeled:            |
| E-Beans:                             | Source of Rate Coefficients Used in Code: |
| Self-Sustained;                      | Journe of Marc Occurrences of the Code;   |
| UV-Instituted:                       |   |
| Others (specify):                    | LINE PROFILE MODELS ( );                  |
|                                      | Doppler Broadening:                       |
| Secondary Innization (Reference)     | Collisional Broadening:                   |
| Attachment:                          |   |
| Detachment:                          | Others (specify):                         |
| lon-Ion Recom-<br>bination           |   |
| Charge Transfer:                     | 4. RECIRCULATION CONTAMINANTS             |
| Dissociation/                        | MODELED ( <b>√</b> ):                     |
| Recombination:                       | O <sub>X</sub> : OH <sub>X</sub> :        |
| Others specify):                     | NO <sub>x</sub> : HNO <sub>x</sub> :      |
|                                      | Others (specify):                         |
| Source of Rate Coefficients Used:    |   |
| AERL's experimental values           | REFERENCE FOR REACTION MECHANISM          |
| DISCHARGE POWER INPUT MODELED (1):   | AND RATES:                                |
| Uniform: Non-Uniform:                |   |
| E-Field: V                           | OTHER UNIQUE FEATURES:                    |
|                                      |   |
| Others (specify):                    |   |
|                                      |   |
|                                      |   |

| CODE NAME: EBEAM   | TECHNICAL AREA(S): Kinetics  |
|--|--|
|  | : Laser Cavity, Lasing Gas, Electrical Power   |
|  | ATION(S) OF CODE: Compute time history of electric laser   |
|  | EBEAM or axial lasers. Input requires electric power   |
| input, laser cavity spe  | cifications, and gas species and densities.  |
|  |  |
| ASSESSMENT OF CAPABILITIES:<br>favorably with experime   | The code is compact and fast. Output values compare ntal values.   |
|  |  |
|  | Kinetics are approximated to speed the computations. limited to CO <sub>2</sub> , He, N2, and water vapor.   |
| OTHER UNIQUE FEATURES:   | ain spike values are computed.   |
|  |  |
| ORIGINATOR/KEY CONTACT:  |  |
| Name: Arthur Werkhe  | iser   |
| Organization: U. S. Ar   |  |
| Address: DRSMI-RHA Di  | rected Energy Directorate, Redstone Arsenal, AL 35898  |
| Phone: (205) 876-816   |  |
|  |  |
| AVAILABLE DOCUMENTATION (I<br>RP = Related Publication): F   | ormal documentation being assembled. Informally,   |
| AVAILABLE DOCUMENTATION (I<br>RP = Related Publication): <u>F</u><br>there is available list   | Please specify, use T = Theory, U = User's Manual, L = Listing, and ormal documentation being assembled. Informally, ing and user's manual.  |
|  |  |
|  |  |
|  |  |
| th <u>ere is available list</u>  |  |
| there is available list  | ing and user's manual.   |
| STATUS:  Operational Currently?:   | ing and user's manual.   |
| STATUS:  Operational Currently?:   | ring and user's manual.  |
| STATUS:  Operational Currently?:   | res  |
| STATUS:  Operational Currently?:   | res res reting a two-dimensional representation of the output.   |
| STATUS:  Operational Currently?:   | res res reting a two-dimensional representation of the output.   |
| STATUS:  Operational Currently?:   | res res res reting a two-dimensional representation of the output.   |
| STATUS:  Operational Currently?:  Under Modification?:  Purpose(s):  Attemption    Ownership?:  Proprietary?:  NO  MACHINE/OPERATING SYSTEM (  | res res res reting a two-dimensional representation of the output.   |
| STATUS:  Operational Currently?:   | res res reting a two-dimensional representation of the output.  on which installed): CDC 6600  |
| STATUS:  Operational Currently?:  Under Modification?:  Purpose(s):  Attemp  Ownership?:  U. S. Army Proprietary?:  NO  MACHINE/OPERATING SYSTEM (  TRANSPORTABLE?:  Yes  Machine Dependent Restriction  | res res reting a two-dimensional representation of the output.  on which installed): CDC 6600  |
| STATUS:  Operational Currently?:  Under Modification?:  Purpose(s):  Attemp  Ownership?:  U. S. Army Proprietary?:  NO  MACHINE/OPERATING SYSTEM (  TRANSPORTABLE?:  Yes   | res res res reting a two-dimensional representation of the output.  on which installed): CDC 6600  |
| STATUS:  Operational Currently?:   | res res res res reing a two-dimensional representation of the output.  on which installed): CDC 6600   |
| STATUS:  Operational Currently?:   | res res res res res reing a two-dimensional representation of the output. res  |
| STATUS:  Operational Currently?:   | res res res res res reing a two-dimensional representation of the output. res  |
| STATUS:  Operational Currently?:   | res res res res res reing a two-dimensional representation of the output. res  |
| STATUS:  Operational Currently?:  Under Modification?:  Purpose(s):  Attemp  Ownership?:  U. S. Army Proprietary?:  NO  MACHINE/OPERATING SYSTEM (  TRANSPORTABLE?:  Yes  Machine Dependent Restricti  SELF-CONTAINED?:  Other Codes Required (name  ESTIMATE OF RESOURCES REQUESTED (  Small Job:  Typical Job:  Typical Job:  Large Job: | res res res res res reting a two-dimensional representation of the output. |
| STATUS:  Operational Currently?:  Under Modification?:  Purpose(s):  Attemp  Ownership?:  U. S. Army Proprietary?:  NO  MACHINE/OPERATING SYSTEM (  TRANSPORTABLE?:  Yes  Machine Dependent Restricti  SELF-CONTAINED?:  Other Codes Required (name  ESTIMATE OF RESOURCES REQUESTED (  Small Job:  Typical Job:  30K                      | res res res res res reting a two-dimensional representation of the output. |

|                                      | CODE NAME: EBEAM   |
|--------------------------------------|--|
| I. CODE STRUCTURE                    | 3. LASING KINETICS MODEL   |
| COORDINATE SYSTEM (1):               | GENERAL (specify):   |
| Cartesian: V Expanding:              | Lasing Species: CO2  |
| KINETICS GRID DIMENSIONALITY (1):    | Number of Species: 3   |
| 1-D: <u>/</u> 2-D:                   | Number of Reactions:   |
| 3-D:                                 | Other Major Species Considered:  |
| GAIN REGION SYMMETRY RESTRICTIONS:   | ower major species considered,   |
| Gain Vary Along Optical Axis:        |  |
| Flow Direction:                      | IMPACT EXCITATION MODELED ( ):   |
| EINETICS MODELED: Pulsed: V CW:      | (Reference)  |
| NUMERICAL SCHEME USED IN RATE        | Vibrational:   |
| CALCULATION ( ):                     | Electronic:  |
| Explicit:                            |  |
| Implicit:                            | Others (specify): not explicitly   |
| Others (specify):                    | defined  |
|                                      | ENERGY TRANSFER MODES MODELED ( 1: (Reference)                                     |
| DETERRICE OF METHOD USED.            | V-T:   |
| REFERENCE OF METHOD USED:            | V-R:   |
|                                      | V-V:   |
|                                      | Others (specify): not explicitly defined   |
| 2. PLASMA KINETICS MODEL             | Lasing Transition: P-Branch:   |
| NUMBER OF SPECIES TREATED (specify): | R-Branch:  |
| Number of Positive Species:          | Single Line Model ( ):   |
| Number of Negative                   | Multi-Line Model (√):  |
| Species: Number of Neutral           | Assumed Rotational Population Distribution State ( $\sqrt{1}$ ):                   |
| Species:                             | Equilibrium:   |
| REACTION MECHANISM MODELED ( ):      | Nonequilibrium:  |
| Primary lonization: (Reference)      | Number of Laser Lines  |
| E-Beam:                              | Modeled: 1   |
| Self-Sustained: 🗸                    | Source of Rate Coefficients Used in Code:  |
| UV-Initiated:                        |  |
| Others (specify):                    |  |
|                                      | LINE PROFILE MODELS ( $$ ):  |
| Secondary lonization (Reference)     | Doppler Broadening:  |
| Attachment:                          | Collisional Broadening:  |
| Detachment:                          | Others (specify):  |
| Ion-Ion Recom-<br>bination:          |  |
| Charge Transfer:                     | 4. RECIRCULATION CONTAMINANTS  |
| Dissociation/<br>Recombination:      | MODELED $(\checkmark)$ :  O <sub>N</sub> : OH <sub>V</sub> :                       |
| Others (specify):                    |  |
|                                      | NO <sub>x</sub> : HNO <sub>x</sub> : not specified others (specify): not specified |
| Source of Rate Coefficients Used:    | REFERENCE FOR REACTION MECHANISM   |
| DISCHARGE POWER INPUT MODELED (V):   | AND RATES:   |
| Umform: Non-Uniform;                 |  |
| E-Fleid:                             | OTHER UNIQUE FEATURES:   |
| Others (specify): all three can be   |  |
| selected.                            |  |
| 20100041                             |  |

| CODE NAME: EBER  | u12  | _ TECHNICAL AREA   | \(S):       | Kinetics           |                    |
|--|--|--|-------------|--------------------|--------------------|
| DEVICE COMPONENTS  | TREATED:P  | ower Supply  |             |                    |                    |
| PRINCIPAL PURPOSE(   | S)/APPLICATION   | S) OF CODE: Giv  | en powe     | r supply           | specifications -   |
|  |  | s the E-Beam gur<br>nd densities are   |             |                    | oltage and curre   |
| - I I I I I I I I I I I I I I I I I I I  | oas species a  | nu densities are   | a150 1      | npuccea.           |                    |
|  |  |  |             |                    |                    |
| ASSESSMENT OF CAPA   | BILITIES: Prov   | ides a graphical   | displa      | y of curr          | ent and voltage    |
| for each of the  | two electric   | al systems in a  | pulsed 1    | E-beam la          | ser.               |
|  |  |  |             |                    |                    |
| ASSESSMENT OF LIMI   | TATIONS: Rest  | ricted to CO. N  | and H       | E Gas Svs          | tems.              |
| Laser outputted  | not computed   |  | 2           |                    | - W                |
|  |  |  |             |                    |                    |
| OTHER UNIONE SEAT  | unec. was no   | ed in a compari  | son bett    | roon theo          | ry and experimen   |
| OTHER UNIQUE FEAT<br>Easily showed 9   |  | icient dependenc   |             | ween_theo          | ry and experimen   |
|  |  |  |             |                    |                    |
|  |  |  |             |                    |                    |
| ORIGINATOR/KEY CO  |  |  |             |                    |                    |
| Name: AFTI   | ur Werkheiser<br>S Army Missil   | e Command  |             |                    |                    |
| Address: DRS   | MI-RHA. Direc  | ted Energy Direc   | torate.     | Redstone           | Arsenal, AL 358    |
| (205)  | 876-8161   | 2  | , coruco,   | illoud come        | in bendly has 550  |
| Phone: (203)   |  |  |             |                    |                    |
| Phone: (205)  AVAILABLE DOCUME   | NTATION (Please s  | pecify, use T = Theor  | ry, U = Use | r's Manual,        | L = Listing, and   |
| AVAILABLE DOCUMENT RP = Related Pub  | NTATION (Please solication):   | pecify, use T = Theor  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMENT RP = Related Pub  | NTATION (Please s  | pecify, use T = Theor  | ry, U = Use | er's Manual,       | L = Listing, and   |
| AVAILABLE DOCUMENT RP = Related Pub  | NTATION (Please solication):   | pecify, use T = Theor  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMENT RP = Related Pub  | NTATION (Please solication):   | pecify, use T = Theor  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMENT RP = Related Pub  | NTATION (Please solication):   | pecify, use T = Theor  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMEI<br>RP = Related Pub<br>Under pre   | NTATION (Please solication):   | pecify, use T = Theor  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMEI RP = Related Pub Under pre   | NTATION (Please solication); eparation. eparation.                                     | pecify, use T = Theor  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification  | entiy?: yes  |  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification  | NTATION (Please solication); eparation. eparation.                                     |  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification  | entiy?: yes  |  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification  | entive: yes  |  | ry, U = Use | er's Manual,       | , L = Listing, and |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s):  | entiy?: yes  |  |             |                    | , L = Listing, and |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s): Cwnership?:  | ently?: yes on?: no  |  |             | 11/34              | , L = Listing, and |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s):  Cwnership?: Under Modification Purpose(s):  Cwnership?: MACHINE/OPERATING   | entiy?: Yes on?: NO S Army NO S SYSTEM (on whice                                       | h installed):DEC   |             |                    | L = Listing, and   |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s):  Cwnership?: Under Modification Purpose(s): Transportable?:  | ently?: yes on?: no  SYSTEM (on whice  | h installed):DEC   | PDP :       | 11/34              |                    |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s):  Cwnership?: Under Modification Purpose(s): Transportable?:  | ently?: yes on?: no  SYSTEM (on whice  | h installed): DEC  | PDP :       | 11/34              |                    |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s):  Cwnership?: Under Modification Purpose(s): Transportable?:  | ently?: yes on?: no  SYSTEM (on whice  | h installed): DEC  | PDP :       | 11/34              |                    |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s):  Cwnership?: Under Modification Purpose(s):  TRANSPORTABLE?: Machine Depende  SELF-CONTAINED?:   | entiy?: Yes on?: NO SYSTEM (on whice ont Restrictions                                  | h installed): DEC  | PDP         | 11/34<br>s 4012 te | rminal             |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s):  Cwnership?: Under Modification Purpose(s):  TRANSPORTABLE?: Machine Depende  SELF-CONTAINED?: Other Codes Requi   | entiy?: yes on?: no  S Army No S SYSTEM (on whice ont Restrictions                     | h installed): DEC  Requires a Te   | PDP         | 11/34<br>s 4012 te | rminal             |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s): Purpose(s): Proprietary?: MACHINE/OPERATING TRANSPORTABLE?: Machine Depende SELF-CONTAINED?: Other Codes Requestion  | entiy?: yes on?: no  S Army No S SYSTEM (on whice ont Restrictions  aired (name, purpo | h installed):DEC<br>Requires a Te  | PDP :       | 11/34<br>s 4012 te | rminal             |
| AVAILABLE DOCUMEI RP = Related Pub Under pre  STATUS: Operational Curr Under Modification Purpose(s): Purpose(s): Proprietary?: MACHINE/OPERATING TRANSPORTABLE?: Machine Depende SELF-CONTAINED?: Other Codes Requestion  | entiy?: yes on?: no  S Army No S SYSTEM (on whice ont Restrictions                     | h installed): DEC  Requires a Te   | PDP :       | 11/34<br>s 4012 te | rminal             |
| AVAILABLE DOCUMER RP = Related Pub Under pre Under pre  STATUS: Operational Curr Under Modification Purpose(s): Purpose(s): Proprietary?: MACHINE/OPERATING  TRANSPORTABLE?: Machine Depende  SELF-CONTAINED?: Other Codes Requested   | entiy?: yes on?: no  S Army No S SYSTEM (on whice ont Restrictions  aired (name, purpo | h installed):DEC<br>Requires a Te  | PDP :       | 11/34<br>s 4012 te | rminal             |
| AVAILABLE DOCUMER RP = Related Pub Under pre Under pre  STATUS: Operational Curr Under Modification Purpose(s): Purpose(s): Proprietary?: MACHINE/OPERATING TRANSPORTABLE?: Machine Depende  SELF-CONTAINED?: Other Codes Requested ESTIMATE OF RESOU Small Job:   | entiy?: yes entiy?: yes on?: no  S Army No S SYSTEM (on whice no nt Restriction.       | h installed):DEC<br>Requires a Te  | PDP :       | 11/34<br>s 4012 te | rminal             |
| AVAILABLE DOCUMER RP = Related Pub Under pre Under pre  STATUS: Operational Curr Under Modification Purpose(s): Purpose(s): Proprietary?: MACHINE/OPERATING  TRANSPORTABLE?: Machine Depende  SELF-CONTAINED?: Other Codes Requested Self-Contained Codes Requested Self-Codes Self-Codes Requested Self-Codes Se | entiy?: yes entiy?: yes on?: no  S Army No S SYSTEM (on whice no nt Restriction.       | h installed):DEC  Requires a Te  se):Requires Te  TOR RUNS: ds)   Execution Ti | PDP :       | 11/34<br>s 4012 te | rminal             |

I. CODE STRUCTURE

3-D: \_

COORDINATE SYSTEM ( ):

1-D: \_\_\_\_\_ 2-D: \_\_\_

Flow Direction:

CALCULATION (V):

Implicit: V
Others (specify):

2. PLASMA KINETICS MODEL

Species:

Species:

Species:

Number of Positive

Number of Negative

Number of Neutral

Primary lonization:

E-Beam:

Self-Sustained: UV-Initiated: Others (specify):

Secondary Ionization

Attachment:

Charge Transfer;

Dissociation/

E-Field; \_\_\_\_\_Others (specify): \_

Recombination:

Others (specify):

Source of Rate Coefficients Used: \_\_\_

DISCHARGE POWER INPUT MODELED (√):
Uniform: Non-Uniform: ✓

Detachment: Ion-Ion Recombination:

Explicit: \_

Cartesian: Expanding:

KINETICS GRID DIMENSIONALITY ( ):

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: \_\_\_\_\_\_

KINETICS MODELED: Pulsed: \_V \_ CW:

NUMERICAL SCHEME USED IN RATE

REFERENCE OF METHOD USED: \_\_\_

NUMBER OF SPECIES TREATED (specify):

REACTION MECHANISM MODELED (1):

(Reierence)

(Reference)

CODE NAME: EBEAM2 3. LASING KINETICS MODEL GENERAL (specify): Lasing Species: 1 Number of Species: Number of Reactions: Other Major Species Considered: IMPACT EXCITATION MODELED (√): (Reference) Vibrational: Electronic: Others (specify): ENERGY TRANSFER MODES MODELED ( ): (Reference) V-T:\_\_\_ V-R: \_\_\_ V - V: Others (specify): Lasing Transition: P-Branch: R-Branch: Single Line Model ( ): Multi-Line Model (√): \_\_ Assumed Rotational Population Distribution State ( ): Equilibrium: Nonequilibrium: Number of Laser Lines Modeled: Source of Rate Coefficients Used in Code: LINE PROFILE MODELS ( ): Doppler Broadening: Collisional Broadening: Others (specify): \_\_\_\_ 4. RECIRCULATION CONTAMINANTS MODELED (**√**): none Ox: \_\_\_ NO.: \_\_\_\_ HNO<sub>x</sub>: Others (specify): \_ REFERENCE FOR REACTION MECHANISM AND RATES: OTHER UNIQUE FEATURES:

| 38 |
|----|

| CODE NAME:       | EBM2D                           | TE       | CHNICAL A  | REA(S):                                |           | Kinetics    |         |
|------------------|---------------------------------|----------|------------|--|-----------|-------------|---------|
| DEVICE COMPONEN  | ITS TREATED:                    | Lase     | r Cavity,  | Gas                                    |           |             |         |
| PRINCIPAL PURPOS | E(S)/APPLICATION                | (S) OF   | CODE: EF   | M2D Compu                              | tes a 2-  | dimensiona  | 1       |
| distribution     | of electron der                 | sity,    | electric   | field, a                               | ind power | deposited   | within  |
|                  | y for a given p                 | otent    | ial diffe  | rence and                              | current   | density     | IOI     |
| electric lase    | rs.                             |          |            |  |           |             |         |
| ASSESSMENT OF CA | PABILITIES: Co                  |          |            |  |           |             | send    |
| ASSESSMENT OF LI | MITATIONS: Reite a time history |          |            |  |           | distributi  | on.     |
| OTHER UNIQUE FE  | ATURES: Makes                   | use o    | f cavity   | symmetry.                              | · Includ  | ies several |         |
| empiracal app    | roximations to                  | speed    | the calc   | ulations.                              | Presup    | poses an E  | BEAM.   |
| laser.           |                                 |          |            |  |           |             |         |
| ORIGINATOR/KEY   | CONTACT:                        |          |            | ······································ |           | <del></del> |         |
|                  | ur Werkheiser                   |          |            |  |           |             |         |
|                  | U.S. Army Mi                    |          |            |  |           |             |         |
|                  | RSMI-RHA Direct                 | ted En   | ergy Dir   | ectorate,                              | Redstone  | Arsenal,    | AL 3589 |
| Phone: (205      | 876-8161                        |          |            |  |           |             |         |
| AVAILABLE DOCUM  |                                 |          |            |  |           |             |         |
|                  | , Cason, C., Pe                 |          |            |  | iser, A.  | 1., AIAA Jo | urnal,  |
| VOI. 15, NO.     | 8, Aug. 1977,                   | pp. 10   | 779 - 106. | 3 (1)                                  |           |             |         |
|                  |                                 |          |            |  |           |             |         |
|                  |                                 |          |            |  |           |             |         |
| CTA THE          |                                 |          |            |  |           |             |         |
| STATUS:          | rrently?: yes                   |          |            |  |           |             |         |
|                  | tion?; yes                      | _        |            |  |           |             |         |
|                  | combining t                     | his wi   | th EBEAM   | to produc                              | ce a two- | -dimensiona | 1       |
| time history.    |                                 |          |            |  |           |             |         |
|                  | US Army                         |          |            |  |           |             |         |
| Ownership?;      |                                 |          |            |  |           |             |         |
| Proprietary?:    |                                 |          |            |  |           |             |         |
| MACHINE/OPERAT   | ING SYSTEM (on whi              | ch insta | (led);C    | DC 6600                                |           |             |         |
| TRANSPORTABLE?   | yes                             |          |            |  |           |             |         |
| Machine Deper    | dent Restrictions:              | no       |            |  |           |             |         |
| SELF-CONTAINED?  |                                 |          |            |  |           |             |         |
|                  | equired (name, purp             | ose):    |            |  |           |             |         |
| ESTIMATE OF RESC | OURCES REQUIRED                 | FOR RU   | JNS:       |  |           |             |         |
|                  | Core Size (Octal Wo             | rds)     | Execution  | Time (sec,                             | CDC 7600) |             |         |
| Small Job;       | 201                             |          | 1.5        |  |           |             |         |
| Typical Job:     | 30K                             |          | 15         | sec                                    |           |             |         |
| Large Job:       |                                 |          |            |  |           |             |         |
| Approximate N    | lumber of FORTRAN               | Lines:   | 400        |  |           |             |         |
|                  |                                 |          |            |  |           |             |         |

| CODE STRUCTURE                                    | 3. LASING KINETICS MODEL                  |
|---|---|
| COORDINATE SYSTEM (√):                            | GENERAL (specify):                        |
| Cartesian: V Expanding:                           | Lasing Species: CO2                       |
| KINETICS GRID DIMENSIONALITY (1):                 |   |
| 1-D: 2-D:   | Number of Species: 3                      |
| 3-D: _  | Number of Reactions:                      |
|   | Other Major Species Considered:           |
| GAIN REGION SYMMETRY RESTRICTIONS:                | <del></del>                               |
| Gain Vary Along Optical Axis:                     |   |
| Flow Direction:                                   | IMPACT EXCITATION MODELED (♥):            |
| KINETICS MODELED: Pulsed: CW:                     | (Reference)                               |
| NUMERICAL SCHEME USED IN RATE<br>CALCULATION (√): | Vibrational:                              |
|   | Electronic:                               |
| Explicit:   | Others (specify):                         |
| Implicit:   |   |
| Others (specify):                                 | ENERGY TRANSFER MODES MODELED ( ):        |
|   | (Reference)                               |
|   | V-T:                                      |
| REFERENCE OF METHOD USED:                         |   |
|   |   |
|   | V-V:                                      |
| PLASMA KINETICS MODEL                             | Others (specify):                         |
| NUMBER OF SPECIES TREATED (specify);              | Lasing Transition: P-Branch:              |
| Number of Positive                                | R-Branch:                                 |
| Species:  | Single Line Model (√):                    |
| Number of Negative                                | Multi-Line Model (√):                     |
| Species:  | Assumed Rotational Population             |
| Number of Neutral                                 | Distribution State ( ):                   |
| Species:  | Equilibrium:                              |
| REACTION MECHANISM MODELED ( 1:                   | Nonequilibrium:                           |
| Primary lonization: (Reference) E-Beam;           | Number of Laser Lines Modeled:            |
| Self-Sustained:                                   | Source of Rate Coefficients Used in Code: |
| UV-Initiated:                                     |   |
|   |   |
| Others (specify):                                 | LINE PROFILE MODELS ( ):                  |
|   | ▼   |
| Secondary Ionization (Reference)                  | Doppler Broadening:                       |
| Attachment: .                                     | Collisional Broadening:                   |
| Detachment:                                       | Others (specify):                         |
| lon-lon Recom-                                    |   |
| Charge Transfer:                                  | 4. RECIRCULATION CONTAMINANTS             |
| D :!/   | MODELED $()$ : none                       |
| Recombination:                                    | O <sub>x</sub> : OH <sub>x</sub> :        |
| Others (specify):                                 | NO: HNO:                                  |
|   | Others (specify):                         |
| Source of Rate Coefficients Used:                 |   |
|   | REFERENCE FOR REACTION MECHANISM          |
| DISCHARGE POWER INPUT MODELED (1):                | AND RATES:                                |
| Uniform: Non-Uniform:                             |   |
| initorni: V Non-Unitorni:                         | OTHER UNIQUE FEATURES:                    |
|   |   |
| E-Field: Others (specify):                        |   |

| CODE NAME:_                             | EDLAMP                                  | TECHNICAL AREA(S): Kinetics, Gas Dynamics                        |
|---|---|--|
| DEVICE COMP                             |   | Cavity   |
| PRINCIPAL PU                            | R POSE(S)/A PPLICAT                     | TION(S) OF CODE:   |
| Cavity                                  | Performance                             |  |
|   |   |  |
| <del></del>                             |   |  |
| ASSESSMENT (                            | OF CAPABILITIES:_                       | Suited for any E-Beam controlled EDL                             |
|   |   |  |
|   |   |  |
|   |   |  |
|   |   | One-D Only (Flow distance for CW applications,                   |
| time for p                              | oulsed application                      | on)  |
|   |   |  |
| OTHER UNION                             | F FFA TUDES. Deta                       | niled Plasma Kinetics; code can model kinetics                   |
| effects du                              | e to recirculat:                        | on on performance.   |
|   |   |  |
|   |   |  |
|   | KEY CONTACT:                            |  |
| Name:                                   | Jurgen Thoenes                          |  |
|   |   | untsville Research & Engineering Center                          |
|   |   | Huntsville, AL 35807   |
| _                                       | (205) 837-1800                          | ase specify, use T = Theory, U = User's Manual, L = Listing, and |
|   | ated Publication):                      |  |
|   |   | Kurzius, "Plasma Chemistry Processes in the Closed               |
|   |   | TR DRCPM-HEL-CR-79-11, 1979, Vol. I.                             |
|   |   | MP User's Manual", MICOM   |
| Tr                                      | C DRCPM-HEL-CR-7                        | 9-11, Vol. II, 1979.   |
|   |   |  |
| STATUS:                                 | on I Commonthus. NO.                    |  |
|   | nal Currently?: <u>ye</u> odification?: |  |
|   | ose(s):                                 |  |
|   |   |  |
|   |   |  |
| Ownershi                                | p?: Lockheed &                          | U.S. Army, MICOM   |
|   | ary?: No                                |  |
| MACHINE/OPE                             | ERATING SYSTEM (on                      | which installed): CDC 6600 (MICOM), CYBER 176 (AFWL)             |
| TRANSPORTA                              | DIF2. VAS                               |  |
| TRANSPORTA                              |   | s: none for CDC Computers  |
| ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | Dependent Restriction                   | Y:   |
| SELF-CONTAI                             | NED?:                                   |  |
| Other Co                                | des Required (name,                     | ourpose): Boltzmann Electron Kinetics Code.                      |
|   |   |  |
| ESTIMATE OF                             | RESOURCES REQUIF                        | ED FOR RUNS:   |
|   |   | Words) Execution Time (sec, CDC 7600)                            |
| Small Joi                               |   |  |
| Typical J                               |   | 60   |
| Large Jo                                | nate Number of FORT                     | PAN Lines: 5000  |
| COMMENTS:                               |   | 5000   |
| _                                       |   | ed using geometric optics.                                       |
|   |   |  |

|   | CODE NAME: EDLAMP  |
|---|--|
| CODE STRUCTURE                            | 3- LASING KINETICS MODEL   |
| COORDINATE SYSTEM (√):                    | GENERAL (specify):   |
| Cartesian: Expanding:                     | Lasing Species: CO2  |
| KINETICS GRID DIMENSIONALITY ( ):         | Number of Species: Arbitrary   |
| 1-D:                                      | Number of Reactions: Arbitrary   |
| 3-D;                                      | Other Major Species Considered:  |
| GAIN REGION SYMMETRY RESTRICTIONS:        | N <sub>2</sub> , He, O <sub>2</sub> , H <sub>2</sub> , CO  |
| Gain Vary Along Optical Axis:             | 11/1 11/1 0/1 11/1 00  |
| Flow Direction;                           | IMPACT EXCITATION MODELED ( ):   |
| KINETICS MODELED: Pulsed: V CW: V         | (Reference)  |
| NUMERICAL SCHEME USED IN RATE             | Vibrational:   |
| CALCULATION ():                           | Electronic:  |
| Explicit:                                 |  |
| Implicit:                                 | Others (specify): Ionization   |
| Others (specify):                         | ENERGY TRANSFER MODES MODELED (1)  |
|   | ENERGY TRANSFER MODES MODELED ( ):   |
|   | (Reference)  |
| REFERENCE OF METHOD USED:                 | v-T:   |
|   | V-R;   |
|   | V-V:   |
| PLASMA KINETICS MODEL                     | Others (specify):  |
| NUMBER OF SPECIES TREATED (specify);      | Lasing Transition: P-Branch:   |
| Number of Positive                        | R-Branch:  |
| Species: Arbitrary                        | Single Line Model ( ):   |
| Number of Negative                        | Multi-Line Mode) (√):  |
| Species: Arbitrary                        | Assumed Rotational Population  |
| Number of Neutral Species: Arbitrary      | Distribution State ( ):  |
| Species:  REACTION MECHANISM MODELED (√): | Equilibrium:   |
| Primary Ionization; (Reference)           | Nonequilibrium:  |
| E-Beam;                                   | Number of Laser Lines  Modeled:  |
| Self-Sustained:                           | Source of Rate Coefficients Used in Code:  |
|   |  |
| Others (specify):                         |  |
| Others (spectry):                         | LINE PROFILE MODELS ( ):   |
| Secondary Ionization (Reference)          | Doppler Broadening:  |
| Attachment:                               | Collisional Broadening:  |
| Detachment:                               | Others (specify):  |
| Ion-Ion Recom-                            | Combination (Voigt Profile)  |
| bination:                                 | 00   |
| Charge Transfer:                          | 4. RECIRCULATION CONTAMINANTS  |
| Dissociation/                             | MODELED ():  |
| Recombination:                            | Ox: OHx:   |
| Others (specify):                         | NO <sub>x</sub> : HNO <sub>x</sub> : V   |
|   | Others (specify):  |
| Source of Rate Coefficients Used:         |  |
|   | REFERENCE FOR REACTION MECHANISM   |
| DISCHARGE POWER INPUT MODELED ( ):        | AND RATES:   |
| Uniform; Non-Uniform;                     | - The state of the |
| E-Field:                                  | OTHER UNIQUE FEATURES:   |
| Others (specify):                         |  |
| ()thers (specify):                        |  |

#### GAS DYNAMICS CODE

CODE NAME: EDLAMP

1. CODE STRUCTURE DECONTAMINATION METHOD TREATED (√): COORDINATE SYSTEM ( ): Scrubber: Cartesian: \_\_\_\_ Expanding: Shower: FLUID GRID DIMENSIONALITY ( ): Catalytic Reactor: I-D: Others (specify): \_\_Scrubber/Catalytic 2-D:\_\_\_\_ reactor modeled by adjusting mixture 3-D: composition. Time Dependent; \_ FLOW FIELD MODELED ( ): 4. ACOUSTIC ATTENUATION MODEL Compressible Flow: GENERAL FEATURES MODELED ( ): Incompressible: Single Pulse: \_\_\_\_ Repetitive Pulse: \_\_\_ DIMENSIONALITY TREATED ( ): Viscous Flow: No Flow: 1-D:\_\_\_\_\_ 2-D:\_\_\_\_ 3-D:\_\_ BASIC MODELING APPROACH (√): Time-Dependent: Algebraic: \_\_\_\_ Integral Method: \_\_\_ DISTURBANCE MODELED ( ): Finite Difference: Pressure Wave: \_\_\_\_ Entropy Wave: \_ Others (specify): Others (specify):\_\_\_ REFERENCE FOR APPROACH USED:\_\_\_\_ WAVE PROPAGATION TREATMENT (√): Linear Wave: \_\_\_\_\_ Nonlinear Wave: Others (specify): \_\_\_\_ 2. GAS DYNAMICS MODEL FEATURES: GAS SUPPLY MODELED (♥): THEORETICAL BASIS: (Reference) Mixture Preparation: Mixture Injection: Nozzles: NUMERICAL METHODOLOGY: (Reference) Flow Plates: \_\_\_ Others (specify): ACOUSTIC ATTENUATORS CONSIDERED ( ): CAVITY INITIAL CONDITION DETERMINED Muffler: \_\_\_\_ Heat Exchanger: \_\_\_\_ BY (specify): qiven P, T, U, Equil. Horn: \_\_\_\_ Porous Wall: \_\_\_\_ concentrations Others (specify): 3. EXHAUST/RECIRCULATION MODEL GENERAL SYSTEM MODELED (√): 5. MODEL EFFECTS ON OPTICAL MODES DUE Open System: V Closed System: TO (1): Closed Cycle: Index of Refraction Variation?: EXHAUST SYSTEM FEATURES ( 1): Other (specify):\_\_ Pressure Recovery: Ejector System: Compressor/Fan; OTHER UNIQUE FEATURES: \_\_\_ Heat Exchanger: Gas Make-Up: Others (specify): Heat exchanger modeled via specified drop in T. Make-up modeled by adjusting mixture composition.

| D T   | ECHNICAL AREA(S):  | Kinetics  |
|---|--|---|
|   |  |   |
| S)/APPLICATION(S) O                         | F CODE: Small sign   | al gain and energy  |
|   |  |   |
| 2   |  |   |
|   |  |   |
|   |  |   |
| BILITIES: Both ve                           | rsions of this cod   | e have demonstrated good  |
| experimental data                           | from Humdinger, A  | BEL, and the AFWL   |
|   |  |   |
|   |  |   |
| TATIONS: _ The ene                          | rgy extraction rou   | tine is not based on physical   |
| s, so prediction                            | s are of limited u   | tility. The code assumes unifo  |
| and electron dens                           | ity.   |   |
|   |  |   |
| JRES:                                       |  |   |
|   |  |   |
|   |  |   |
|   |  |   |
| TACT:                                       |  |   |
| bert F. Walter                              |  |   |
| AFWL/AREP                                   |  |   |
| and AFB, NM 87                              | 117  |   |
|   |  |   |
|   | fv. use T = Theory, U = 1  | User's Manual, L = Listing, and   |
| lication): L                                | -,,  |   |
| -74-216                                     |  |   |
| . Phys. 46, 3566,                           | Aug. 1975  |   |
|   |  |   |
|   |  |   |
|   |  |   |
|   |  |   |
| entlys. yes                                 |  |   |
|   |  |   |
|   | and current input  | waveforms of  |
|   |  |   |
| cy comporar pro-                            |  |   |
| US AirForce                                 |  |   |
|   |  |   |
|   | and and a  | CDC 6600  |
| SISIEM (on which the                        | starred): CRAY-1   | LDC 6600  |
|   |  |   |
|   | -  |   |
| it Kestrictions:                            |  |   |
|   |  |   |
|   | TOHHANK - Boltzman   | nn Equation Code required   |
| ate electron exc                            | itation rates.   |   |
|   |  |   |
|   |  |   |
| RCES REQUIRED FOR                           |  |   |
| RCES REQUIRED FOR<br>tre Size (Octal Words) |  | c, CDC 7600)  |
| re Size (Octal Words)                       | Execution Time (sec  |   |
|   |  |   |
| (200,000)                                   | Execution Time (sec<br>2 sec. on CRAY  |   |
| (200,000)                                   | Execution Time (sec  |   |
|   | TREATED:Cavi- s)/APPLICATION(S) O. S)/APPLICATION(S) O. D) EDL's.  BELITIES: Both verification and electron dense and electron dense and electron dense and electron dense and AFB, NM 87 4-1786 ATATION (Please specification):L-74-216 . Phys. 46, 3566,  ently?:yes Provide voltage ry temporal proficus AirForce no s SYSTEM (on which income and electrons: | TREATED:Cavity  S)/APPLICATION(S) OF CODE: Small sign  CO_EDL's.  ABILITIES: Both versions of this code experimental data from Humdinger, A comparison of this code experimental data from Humdinger, A comparison of the code experimental data from Humdinger, A comparison of the code experimental data from Humdinger, A comparison of the code experimental data from Humdinger, A comparison of the code experimental data from Humdinger, A code exp |

|                                      | CODE NAME: EDLNOD   |
|--------------------------------------|---|
| CODE STRUCTURE                       | 3. LASING KINETICS MODEL  |
| COORDINATE SYSTEM (√):               | GENERAL (specify):  |
| Cartesian: Expanding:                | Lasing Species: 1   |
| KINETICS GRID DIMENSIONALITY (1):    | Number of Species: 4  |
| 1-D:                                 | Number of Reactions:  |
| 3-D:                                 | Other Major Species Considered:                                       |
| GAIN REGION SYMMETRY RESTRICTIONS:   |   |
| Gain Vary Along Optical Axis:        |   |
| Flow Direction:                      | IMPACT EXCITATION MODELED ( ):  |
| KINETICS MODELED: Pulsed: V CW:      | (Reference)   |
| NUMERICAL SCHEME USED IN RATE        | Vibrational:  |
| CALCULATION (1):                     | Electronic:   |
| Explicit:                            | Others (specify):   |
| Implicit:                            | Others (spectry):   |
| Otners (specify):                    | ENERGY TRANSFER MODES MODELED ( ):                                    |
| J. Appl. Phys. 46, 3566, Aug. 1975   | V-T: (Reference)<br>V-R:  |
|                                      | V-V:  |
| PLASMA KINETICS MODEL                | Others (specify):   |
| NUMBER OF SPECIES TREATED (specify): | Lasing Transition: P-Branch:  |
| Number of Positive                   | R-Branch:   |
| Species: 0                           | Single Line Model (♥):  |
| Number of Negative                   | Multi-Line Model (√):   |
| Species: Number of Neutral 4         | Assumed Rotational Population Distribution State $\{\sqrt{\cdot}\}$ : |
| Species:                             | Equilibrium:  |
| REACTION MECHANISM MODELED (√);      | Nonequilibrium:   |
| Primary Ionization: (Reference)      | Number of Laser Lines   |
| E-Beam:                              | Modeled:  |
| Self-Sustained:                      | Source of Rate Coefficients Used in Code                              |
| UV-Initiated;                        | AFWL TR-74-216  |
| Others (specify):                    | LINE PROFILE MODELS ( ):  |
|                                      | Doppler Broadening:   |
| Secondary Ionization (Reference)     |   |
| Attachment:                          | Collisional Broadening:   |
| Detachment:                          | Others (specify):   |
| Ion-lon Recom-<br>bination:          |   |
|                                      | 4. RECIRCULATION CONTAMINANTS   |
| Charge Transfer:                     | MODELED ( <b>√</b> ): none  |
| Dissociation/<br>Recombination:      | O <sub>S</sub> :OH <sub>2</sub> :                                     |
| Others (specify);                    | NO : HNO :  |
| Office to forestry/s                 | Others (specify):   |
| Source of Rate Coefficients Used:    | REFERENCE FOR REACTION MECHANISM                                      |
| DISCHARGE POWER INPUT MODELED (1):   | AND RATES:  |
|                                      |   |
| Uniform: V Non-Uniform;              | OTHER UNIQUE FEATURES:  |
| E-Field;                             |   |
| Others (specify):                    |   |

| CODE NAME:   | EDLSL      |                  | TECHNICAL AREA(S): Kinetics  |
|--------------|------------|------------------|--|
|              |            |                  | O_/H_ or He/ N_ EDL Cavity Kinetics  |
| PRINCIPAL PU | RPOSE(S)   | APPLICATION(S    | s) of code: Models the Kinetics of photon  |
| production   | n by a     | glow discharg    | ge in an EDL cavity containing CO, N, and H,   |
| or He usi    | ng the     | 6-temperature    | e model of AVCO written by Dr. A.T. Gavrielides  |
| of the AF    | WL.        |                  |  |
|              |            |                  |  |
|              | m sprea    | ding, has no     | ast and simple algorithm which does not account optics in it, and assumes a constant average |
| N which      | is an i    | nput.            |  |
|              |            |                  |  |
|              |            |                  | been anchored to other codes such as that of   |
| Lockheed     | and has    | shown agreem     | ment within 10-15%.  |
|              |            |                  |  |
| OTHER WHOLE  |            | rc               |  |
| OTHER UNIQUE | FEATUR     | E5:              |  |
|              |            |                  |  |
|              |            |                  |  |
| ORIGINATOR/K | EY CONT    | ACT:             |  |
| Name:        | Α.         | T. Gavrielide    | es   |
| Organizat    | ion. A     | FWL/LRE          |  |
| Address:     | Kirtl      | and AFB, N.M.    | . 87106  |
| Phone:       | (505) 8    | 44-4691          |  |
| AVAILABLE DO | CUMENT     | ATION (Please s  | specify, use T = Theory, U = User's Manual, L = Listing, and                                 |
| RP = Rela    | ted Public | cation):none     | sed by a limited number of people.   |
| IIIIS IS a   | 11 111-11  | ouse code da     | sed by a limited number of people.   |
|              |            |                  |  |
| <del></del>  |            |                  |  |
|              |            |                  |  |
|              |            |                  |  |
| STATUS:      |            |                  |  |
|              |            | tly?: <u>yes</u> |  |
|              |            | ?:               |  |
| Purp         | ) se(s):   |                  |  |
|              |            |                  |  |
| Ownershi     | AFW        | L/LRE            |  |
|              | ry?: n     |                  |  |
|              |            | YSTEM (on which  | h installed). CDC 6600/ CYBER 176  |
| NOSBE op     |            | •                |  |
| TRANSPORTA   |            | rginally         |  |
|              |            | Restrictions:    | Was written for CDC and is not in ANS11 Fortran  |
|              |            |                  |  |
| SELF-CONTAIN | ED?:       |                  |  |
|              |            |                  | se): Requires DISSPLA package and a library  |
| diffe        | rential    | equation so      | lver.  |
| ESTIMATE OF  | RESOURC    | ES REQUIRED F    | OR RUNS:   |
|              | Core       | Size (Octal Word | ds) Execution Time (sec, CDC 7600)   |
| Small Job    | :          |                  |  |
| Typical J    | ob:        | 4992             | 20 sec   |
| Large Job    |            |                  |  |
| Approxim     | ate Numb   | er of FORTRAN I  | Lines: 150   |
| COMMENTS: _  |            |                  |  |
|              |            |                  |  |
|              |            |                  |  |

CODE NAME: EDLSL

| COORDINATE SYSTEM ( ):  Cartesian: Expanding:  KINETICS GRID DIMENSIONALITY ( ):  1-D: 2-D: 3  3-D:  GAIN REGION SYMMETRY RESTRICTIONS:  Gain Vary Along Optical Axis:  Flow Direction: CW:  KINETICS MODELED: Pulsed: CW:  NUMERICAL SCHEME USED IN RATE  CALCULATION ( ): | GENERAL (specify):  Lasing Species: CO  Number of Species: 3  Number of Reactions: 6  Other Major Species Considered:  IMPACT EXCITATION MODELED (1):  (Reference) |
|---|--|
| KINETICS GRID DIMENSIONALITY (♥):  1-D: 2-D:  3-D:  GAIN REGION SYMMETRY RESTRICTIONS:  Gain Vary Along Optical Axis:  Flow Direction:  KINETICS MODELED: Pulsed:  NUMERICAL SCHEME USED IN RATE  | Number of Species: 3  Number of Reactions: 6  Other Major Species Considered:  |
| 1-D: 2-D:  3-D:  GAIN REGION SYMMETRY RESTRICTIONS:  Gain Vary Along Optical Axis:  Flow Direction:  KINETICS MODELED: Pulsed: CW:  NUMERICAL SCHEME USED IN RATE   | Number of Reactions:  Other Major Species Considered:  IMPACT EXCITATION MODELED (√):  |
| 3-D:  GAIN REGION SYMMETRY RESTRICTIONS:  Gain Vary Along Optical Axis:  Flow Direction:   KINETICS MODELED: Pulsed:   NUMERICAL SCHEME USED IN RATE  | Other Major Species Considered:  IMPACT EXCITATION MODELED ( ):  |
| GAIN REGION SYMMETRY RESTRICTIONS:  Gain Vary Along Optical Axis:  Flow Direction:   KINETICS MODELED: Pulsed:   NUMERICAL SCHEME USED IN RATE  | IMPACT EXCITATION MODELED ( <b>√</b> ):  |
| Gain Vary Along Optical Axis:  Flow Direction:   KINETICS MODELED: Pulsed:   NUMERICAL SCHEME USED IN RATE  |  |
| Flow Direction: V KINETICS MODELED: Pulsed: V CW: NUMERICAL SCHEME USED IN RATE   |  |
| NUMERICAL SCHEME USED IN RATE   |  |
| NUMERICAL SCHEME USED IN RATE   | (Reference)  |
|   |  |
| CALCULATION (all):  | Vibrational:   |
| •   | Electronic:  |
| Explicit:   | Others (specify):  |
| Implicit:   |  |
| Others (specify):   | ENERGY TRANSFER MODES MODELED ( ):   |
|   | (Reference)  |
| REFERENCE OF METHOD USED: AVCO 6-temp   | V-T: V   |
| model programmed by Dr. A.T. Gavileide  | V-R: AVCO Handbook   |
| of the AFWL.  | V-V:   |
| . PLASMA KINETICS MODEL   | Others (specify):  |
| NUMBER OF SPECIES TREATED (specify);  | Lasing Transition: P-Branch:   |
| Number of Positive 0  | R-Branch:  |
| Species:  | Single Line Model (♥):   |
| Number of Negative  | Multi-Line Model ( <b>√</b> ):   |
| Species:  | Assumed Rotational Population Distribution State ( );  |
| Number of Neutral 3 Species:  | Equilibrium:   |
| REACTION MECHANISM MODELED (√):   | Nonequilibrium:  |
| Primary Ionization: (Reference)   | Number of Laser Lines  |
| E-Beam;   | Modeled: 1   |
| Self-Sustained: V AFRL Kinetics Handbool  | Source of Rate Coefficients Used in Code:  |
| UV-Initiated;   |  |
| Others (specify):   |  |
|   | LINE PROFILE MODELS ( V):  |
| Secondary Ionization (Reference)  | Doppler Broadening:  |
| Attachment:   | Collisional Broadening:  |
| Detachment:   | Others (specify):  |
| Ion-Ion Recom-  |  |
| bination;   |  |
| Charge Transfer:  | 4. RECIRCULATION CONTAMINANTS MODELED (√): none  |
| Dissociation/   | · · · · · · · · · · · · · · · · · · ·  |
| Recombination:  | O <sub>x</sub> : OH <sub>x</sub> :   |
| Others (specify):   | NO <sub>x</sub> : HNO <sub>x</sub> : Others (specify):   |
| Source of Rate Coefficients Used:   | REFERENCE FOR REACTION MECHANISM   |
| DISCHARGE POWER INPUT MODELED (1):  | AND RATES:   |
| Uniform: V Non-Uniform:   |  |
| E-Field:  | OTHER UNIQUE FEATURES Gain switch spil   |
| Others (specify):   | computed.  |
| Others (spectry):   |  |
|   | plotting capability.   |

| CODE NAME: EED, also called BOLTZECHNICAL AREA(S): Electron Kinetics                         |
|--|
| DEVICE COMPONENTS TREATED: NA  |
| PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: EED solves for the steady-state electron        |
| distribution function using the Boltzmann Equation. Elastics, Inelastic and                  |
| Super-elastic interactions are considered, as well as electron-electron                      |
| Interactions.  |
|  |
| ASSESSMENT OF CAPABILITIES: Very general. It will consider any gas as long as                |
| cross-section data for that gas are available. If no super-elastics or                       |
| electron-electron interactions are included, the code is very fast.                          |
|  |
| ASSESSMENT OF LIMITATIONS: The electron-electron interactions are somewhat untested          |
| and it's not clear if the formulation is correct. If superelastics are included,             |
| the method is slow. Also, it superclastics are included a lot of core memory                 |
| is required.   |
| OTHER UNIQUE FEATURES: Very easy to use, clear output, very little machine-dependen          |
| features. Input is checked for consistency and validity.                                     |
|  |
|  |
| ORIGINATOR/KEY CONTACT:  |
| Name: Henry Happ   |
| Organization: Tetra Corp.  |
| Address: 1325 San Mateo, SE, Albuquerque, NM 87108   |
| Phone: (505) 256-3595  |
| AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and |
| RP = Related Publication): Boltz: A code to solve the Boltzmann Electron Transport Equation, |
| Tetra TR-78-001 (T,U)  |
| retta in 70 ooi (1,0)  |
| Listings are available upon request.   |
|  |
|  |
| STATUS:  |
| Operational Currently?; yes  |
| Under Modification?;   |
| Purpose(s):  |
|  |
| Ownership?: U. S. Government   |
| Proprietary?: No   |
| MACHINE/OPERATING SYSTEM (on which installed): CDC 6600 or 176, CRAY-1                       |
| MACHINE/OPERATING SISTEM (on witten instalted):  |
| TRANSPORTABLE?: Almost   |
| Machine Dependent Restrictions: How the machine orders its display code. Problem             |
| only occurs in one or two lines of code. Also, write statements use A8 formats.              |
| SELF-CONTAINED?: /Finally, NAMELIST is used.   |
| Other Codes Regulred (name, purpose): none   |
| Other Codes Required (name, purpose);  |
| ESTIMATE OF RESOURCES REQUIRED FOR RUNS:   |
| Core Size (Octal Words)   Execution Time (sec, CDC 7600)                                     |
| Small Job: 32533 *   |
| Typical Job: 232433  |
| 222522   |
| Large Job: 232333 Approximate Number of FORTRAN Lines: 2400                                  |
| COMMENTS: * If superelastics are to be included, a large array of size (256,256)             |
| is used. References to this array can be removed if superelastics are not used.              |

|  | OOD NAME. BBD   |
|--|---|
| CODE STRUCTURE   | 3. LASING KINETICS MODEL                                  |
| COORDINATE SYSTEM (√):   | GENERAL (specify):  |
| Cartesian: Expanding:  | Lasing Species:   |
| KINETICS GRID DIMENSIONALITY (√):  | Number of Species:  |
| 1-D: <u>\land 2-D:</u>   | Number of Reactions:                                      |
| 3-D:   | Other Major Species Considered:                           |
| GAIN REGION SYMMETRY RESTRICTIONS:   |   |
| Jain Vary Along Optical Axis:  |   |
| Flow Direction;  | IMPACT EXCITATION MODELED (√):                            |
| KINETICS MODELED: Pulsed: CW:  | (Reference)   |
| NUMERICAL SCHEME USED IN RATE  | Vibrational:  |
| CALCULATION (1):   | Electronic:   |
| Explicit: V  | Others (specify):   |
| Implicit;  |   |
| Others (specify):  | ENERGY TRANSFER MODES MODELED ( ):                        |
|  | (Reference)   |
| The state of the s | V-T:  |
| REFERENCE OF METHOD USED: Thomson,   | V-R:  |
| Smith & Davies, "Boltz: A Code",   | 1. * 1. *   |
| Computer Phys. Comm., V.11, p. 369-383, 1  | Others (specify):   |
| PLASMA KINETICS MODEL  | Lasing Transition: P-Branch:                              |
| NUMBER OF SPECIES TREATED (specify):   | R-Branch;   |
| Number of Positive Species:  | Single Line Model ( V):                                   |
| Number of Negative   | Multi-Line Model (√):                                     |
| Species:   | Assumed Rotational Population                             |
| Number of Neutral  | Distribution State ( ):                                   |
| Species:   | Equilibrium:  |
| REACTION MECHANISM MODELED (√):  | Nonequilibrium:   |
| Primary Ionization: (Reference) E-Beam:  | Number of Laser Lines<br>Modeled:                         |
| Self-Sustained:  | Source of Rate Coefficients Used in Code                  |
| CV-Initiated:  |   |
| Others (specify):  |   |
|  | LINE PROFILE MODELS ( $$ ):                               |
| Secondary ionization (Reference)   | Doppler Broadening:                                       |
| Attachment:  | Collisional Broadening:                                   |
| Detachment:  | Others (specify):   |
| lon-lon Recom-<br>bination:  |   |
| Charge Transfer:   | 4. RECIRCULATION CONTAMINANTS                             |
| Dissociation/<br>Recombination:  | MODELED ( <b>√</b> ):  O <sub>X</sub> : OH <sub>X</sub> : |
| Others (specify):  | NO <sub>x</sub> : HNO <sub>x</sub> : Others (specify):    |
| Source of Rate Coefficients Used:  |   |
|  | REFERENCE FOR REACTION MECHANISM AND RATES:               |
| DISCHARGE POWER INPUT MODELED (√):   | MAYES:  |
| Uniform: Non-Uniform:  | OTHER UNIQUE FEATURES:                                    |
| E-Field:   | OTHER CHIQUE PRATURES:                                    |
| E-Fretti;  |   |

| CODE NAME:ELE               | TECHNICAL AREA(S): Electron kinetics  |
|-----------------------------|---|
|                             | TS TREATED: Laser cavity; electrical excitation   |
| PRINCIPAL PURPOS            | E(S)/APPLICATION(S) OF CODE: To provide an analysis of electron                             |
|                             | nn arbitrary gas mixture (possibly including excited species)                               |
|                             | of electric field by numerical solution of the Boltzmann                                    |
| equation.                   |   |
|                             |   |
| ASSESSMENT OF CA            | PABILITIES: Code provides for electron-molecule, momentum trans                             |
|                             | and electron-electron collisions; quasisteady state approximat                              |
| retains dn <sub>e</sub> /dt | term for electron creation or loss from external ionization,                                |
|                             | zation, attachment, recombination, etc.   |
| ASSESSMENT OF LI            | MITATIONS: No significant limitations.  |
|                             |   |
|                             |   |
| OTHER UNIQUE FEA            | ATURES: Code is more general than most, inasmuch as there are                               |
|                             | scattering processes, electron-electron collisions are include                              |
|                             | collisions are included, and the analysis can be generated for a                            |
| arbitrary numb              | per of species or reacitons. User-oriented, flexible input/out                              |
| ORIGINATOR/KEY C            |   |
|                             | William B. Lacina   |
| Oranniantian                | Northrop Research and Technology Center   |
| Organization:               | One Research Park, Palos Verdes Peninsula, CA 90274   |
|                             | 213) 377-4811 Ext. 362  |
|                             |   |
| RP = Related F              | ENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and Publication): |
| "Theoretic                  | al Modeling of Molecular and Electron Kinetic Processes.                                    |
|                             | tical Formulation of Analysis and Description of Computer                                   |
| Programs. Vol               | . II: Fortran Computer Program Listings, " Northrop Rept.                                   |
| #NRTC-79-7R. J              | January 1979 (T,U,L)  |
|                             |   |
| STATUS:                     |   |
|                             | errently?: Yes  |
| Under Modifica              |   |
|                             | ):  |
| Fulposeta                   | ·   |
| -                           |   |
| Ownership?:                 | Northrop Research & Tech./William B. Lacina   |
|                             | No. Public Domain   |
|                             | ING SYSTEM (on which installed): CDC 6600   |
|                             |   |
| TRANSPORTABLE?              | yes   |
| Machine Depen               | dent Restrictions: yes (word size)  |
|                             |   |
| SELF-CONTAINED?             | yes   |
| Other Codes R               | equired (name, purpose);  |
|                             |   |
| ESTIMATE OF RESC            | DURCES REQUIRED FOR RUNS:   |
|                             | Core Size (Octai Words)   Execution Time (sec, CDC 7600)                                    |
| Small Job;                  |   |
| Typical Job;                |   |
| Large Job:                  |   |
| **                          | lumber of FORTRAN Lines: 4,000  |
| COMMENTS:                   | -1000   |
|                             | tual Boltzmann subroutines (without the main program ELECT and                              |
|                             | I/O routines) are shorter, and could be easily extracted from                               |
|                             | usage elsewhere.  |
| chis code for               | 50  |
|                             | * ·   |

1. CODE STRUCTURE

CODE NAME: ELECT 3. LASING KINETICS MODEL

| GENERAL (specify): N.A.                         |
|---|
| Lasing Species:                                 |
| Number of Species:                              |
| Number of Reactions:                            |
| Other Major Species Considered:                 |
|   |
|   |
| IMPACT EXCITATION MODELED ( ):                  |
| (Reference)                                     |
| Vibrational:                                    |
| Electronic:                                     |
| Others (specify):                               |
|   |
| ENERGY TRANSFER MODES MODELED (√): (Reference)  |
| V-T:  |
| V-R:  |
| V-V:  |
| Others (specify);                               |
| Lasing Transition: P-Branch:                    |
| R-Branch:                                       |
| Single Line Model ( );                          |
| Multi-Line Model (√):                           |
| Assumed Rotational Population                   |
| Distribution State (√1;                         |
| Equilibrium:                                    |
| Nonequilibrium:                                 |
| Number of Laser Lines                           |
| Modeled:  |
| Source of Rate Coefficients Used in Code;       |
|   |
|   |
| LINE PROFILE MODELS ( ):                        |
| Doppler Broadening:                             |
| Collisional Broadening:                         |
| Others (specify):                               |
|   |
| 4. RECIRCULATION CONTAMINANTS MODELED (√): none |
| O <sub>x</sub> : OII <sub>x</sub> :             |
| NO <sub>x</sub> : HNO <sub>x</sub> :            |
| Others (specify):                               |
|   |
| REFERENCE FOR REACTION MECHANISM                |
| AND RATES:                                      |
| OTHER UNIONE EDATURES                           |
| OTHER UNIQUE FEATURES:                          |
|   |
|   |
|   |

| CODE NAME:     | ELENDIF                | TECHNICAL AREA(S):           | Electron Kinetics   |
|----------------|------------------------|------------------------------|---|
|                | NENTS TREATED:         |                              |   |
| PRINCIPAL PUI  | RPOSE(S)/APPLICATIO    | N(S) OF CODE: Time Depo      | endent Boltzmann Code   |
|                |                        |                              |   |
|                |                        |                              |   |
| A COPCOLUENT O | T CARABITATION (1)     | Packward prolongation        | on (using a multi-step, variable                              |
|                |                        |                              | ution of the steady-state                                     |
|                |                        |                              | sses; (3) Time dependent                                      |
|                |                        | the distribution func        |   |
| ASSESSMENT O   | F LIMITATIONS:         |                              |   |
|                |                        |                              |   |
| OTHER UNIQUE   | FEATURES: In a         | addition to computing        | the electron energy distribution                              |
|                |                        |                              | y, drift velocity, characteristi                              |
|                |                        |                              | ients, and energy flow rates                                  |
|                |                        | cluded in the calcula        | cion.   |
| ORIGINATOR/K   |                        |                              |   |
|                | T Gary L. Duke         |                              |   |
| Organizati     | on: AFWAL/POOC-3       |                              |   |
| Address:       | Wright-Patterson       | n AFB, Dayton, OH            |   |
| Phone:         |                        |                              |   |
| AVAILABLE DO   | CUMENTATION (Please    | e specify, use T = Theory, U | = User's Manual, L = Listing, and omputer Program That Solves |
| RP = Rela      | ted Publication): 1.0  | or a Partially Ionize        | d Gas", JILA Information                                      |
| Contor 1       | Conort #10 by Wil      | liam L. Morgan, June         | 1979  |
| center         | Report #19 by Wil.     | Train E. Morgan, bune        | 17.7.   |
|                |                        | ****                         |   |
|                |                        |                              |   |
|                |                        |                              |   |
| STATUS:        |                        |                              |   |
| Operations     | al Currently?: Yes     |                              |   |
| Under Mod      | lification?; NO        | <u> </u>                     |   |
| Purpo          | se(s):                 |                              |   |
|                |                        |                              |   |
|                |                        |                              |   |
| Ownership      |                        |                              |   |
|                | ry?: <u>No</u>         |                              |   |
| MACHINE/OPE    | RATING SYSTEM (on wh   | nich installed):             |   |
| TRANSPORTAB    | LE?: Yes               |                              |   |
|                | ependent Restrictions; | Programmed in For            | tran IV   |
| SELF-CONTAIN   | ED?:                   |                              |   |
|                | es Required (name, pur | pose);                       |   |
| ESTIMATE OF    | RESOURCES REQUIRED     | FOR RUNS:                    |   |
|                | Core Size (Octal W     |                              | mec. CDC 7600)  |
| Small Job      |                        |                              |   |
| Typical Jo     |                        | 15 500                       |   |
|                |                        | 15 Sec                       | ·····   |
| Large Job      |                        | N. 1 inco. 1200              |   |
|                | ate Number of FORTRA   | N Lines: 1200                |   |
| NOTE:          | ELENDIF was broug      | ht to us by MAJT R.D.        | Franklin from Lawrence Lab.                                   |
|                |                        |                              |   |
| current        | ly being used.         | d although Life code 1       | s operational it is not                                       |
| - 4411         | _, ~~~~~               |                              |   |

| CODE NAME: ET  | ranv   | TECHNICAL AREA(S):  | Kinetics                           |
|--|--|---|------------------------------------|
|  | ENTS TREATED:  |   |                                    |
|  |  |   | pendent solution of master         |
|  |  |   | n modeling of vibrational-         |
| rotational la  | aser systems (CC   | O <sub>2</sub> , CO, HF, DF).   |                                    |
|  |  |   |                                    |
| ASSESSMENT OF  | CAPABILITIES: Ti   | ime dependent or stead  | ly state solutions of state        |
|  |  |   | (5) different molecular speci      |
|  |  | solution of collisiona  |                                    |
|  |  |   |                                    |
|  |  |   | and V-T) scaling with respect      |
| to vibration   | al state and tra   | inslational temperatur  | ce.                                |
|  |  |   |                                    |
|  |  |   |                                    |
| OTHER UNIQUE F   | EATURES:   |   |                                    |
|  |  |   |                                    |
|  |  |   |                                    |
| ORIGINATOR/KEY   | CONTACT:   | ····  |                                    |
|  | m. F. Bailey   |   | 1.4                                |
|  |  | Institute of Technolo   |                                    |
| Address:   | Bldg. 640, Area  | B, Wright-Patterson A   | AFB, Ohio 45433                    |
| Phone: 5   | 13-255-2012  |   |                                    |
|  |  |   | = User's Manual, 1. = Listing, and |
| AVAILABLE DOCL   | JMENTATION (Please   | e specify, use 1 = Theory, U  | = User's Manual, I. = Listing, and |
| RP = Related   | Publication):  |   |                                    |
| RP = Related   | Publication):<br>ision Induced Di  | ssociation of Diatomi   |                                    |
| RP = Related   | Publication):  | ssociation of Diatomi   |                                    |
| RP = Related   | Publication):<br>ision Induced Di  | ssociation of Diatomi   |                                    |
| RP = Related   | Publication):<br>ision Induced Di  | ssociation of Diatomi   |                                    |
| RP = Related "Colli AFAPL  | Publication):<br>ision Induced Di  | ssociation of Diatomi   |                                    |
| RP = Related "Colli AFAPL  | Publication):<br>ision Induced Di  | ssociation of Diatomi<br>. 1978 (RP)  |                                    |
| RP = Related "Colli AFAPL  STATUS: Operational (   | Publication): Lision Induced Di LTR-78-105, Nov  | ssociation of Diatomi   |                                    |
| RP = Related "Colli AFAPL  STATUS: Operational of Under Modifi   | Publication):<br>Ision Induced Di<br>I-TR-78-105, Nov  | ssociation of Diatomi   |                                    |
| RP = Related "Colli AFAPL  STATUS: Operational of Under Modifi   | Publication): Liston Induced Di LTR-78-105, Nov  Currently?: X  ication?:  | ssociation of Diatomi   |                                    |
| RP = Related "Colli AFAPL  STATUS: Operational of Under Modifi Purpose   | Publication): Ision Induced Di In | ssociation of Diatomi   |                                    |
| RP = Related "Colli AFAPL  STATUS: Operational ( Under Modifi Purpose  Ownership?:   | Publication): Ision Induced Di I-TR-78-105, Nov  Currentiy?: X ication?: U.S.A.F.  | ssociation of Diatomi   |                                    |
| RP = Related "Colli AFAPL  STATUS: Operational of the colling of t | Currentiy?: X ication?:  U.S.A.F.  | ssociation of Diatomi . 1978 (RP)   | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of the colling of t | Publication): Ision Induced Di I-TR-78-105, Nov  Currentiy?: X ication?: U.S.A.F.  | ssociation of Diatomi . 1978 (RP)   | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Under Modifi Purpose  Ownership?: Proprietary? MACHINE/OPERA   | Currentiy?: X ication?:  U.S.A.F. ?: TING SYSTEM (on where the state of the system)  | ssociation of Diatomi . 1978 (RP)   | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Purpose Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE  | Currentiy?: X ication?:  U.S.A.F. ?: TING SYSTEM (on wh  | ssociation of Diatomi . 1978 (RP)   | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Purpose Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE  | Currentiy?: X ication?:  U.S.A.F. ?: TING SYSTEM (on wh  | ssociation of Diatomi . 1978 (RP)   | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Purpose Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  | Currentiy?: X ication?:  U.S.A.F. ?: TING SYSTEM (on wheel)  | ssociation of Diatomi . 1978 (RP)   | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Purpose Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  | Publication): Ision Induced Di In | ssociation of Diatomi . 1978 (RP)   | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Purpose Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  | Publication): Ision Induced Di In | ssociation of Diatomi . 1978 (RP)   | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Under Modifi Purpose  Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  SELF-CONTAINED Other Codes  | Publication): Ision Induced Di In | ssociation of Diatomi . 1978 (RP)  mich installed): CDC 6600  | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Under Modifi Purpose  Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  SELF-CONTAINED Other Codes  | Publication): Ision Induced Di Induced Ind | ssociation of Diatomi . 1978 (RP)  mich installed): CDC 6600  | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Under Modification of Purpose  Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  SELF-CONTAINED Other Codes   | Currently?: X ication?:  U.S.A.F.  P: TING SYSTEM (on whose the second of the second o | ssociation of Diatomi . 1978 (RP)  mich installed): CDC 6600  | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational of Under Modifi Purpose  Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  SELF-CONTAINED Other Codes  | Currentiy?: X ication?:  U.S.A.F.  P: TING SYSTEM (on whose it is to be in the content of the co | ssociation of Diatomi . 1978 (RP)  mich installed): CDC 6600  | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational ( Under Modifi Purpose  Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  SELF-CONTAINED Other Codes  ESTIMATE OF RE  Small Job: Typical Job: Large Job:   | Currentiy?: X ication?:  U.S.A.F. ?: TING SYSTEM (on whose the structions:  Yes: X pendent Restrictions:  O?: X Required (name, pur)  SOURCES REQUIRED  Core Size (Octal W   | ssociation of Diatomi . 1978 (RP)  mich installed): CDC 6600  pose):  D FOR RUNS: Cords)   Execution Time (a) | c Molecules",                      |
| RP = Related "Colli AFAPL  STATUS: Operational ( Under Modifi Purpose  Ownership?: Proprietary? MACHINE/OPERA  TRANSPORTABLE Machine Dep  SELF-CONTAINED Other Codes  ESTIMATE OF RE  Small Job: Typical Job: Large Job:   | Currentiy?: X ication?:  U.S.A.F. ?: TING SYSTEM (on whose the structions:  Yes: X pendent Restrictions:  O?: X Required (name, pur)  SOURCES REQUIRED  Core Size (Octal W   | ssociation of Diatomi . 1978 (RP)  mich installed): CDC 6600  | c Molecules",                      |

|                                      | CODE NAME:ETRANV                                      |
|--------------------------------------|---|
| . CODE STRUCTURE                     | 3. LASING KINETICS MODEL                              |
| COORDINATE SYSTEM (√):               | GENERAL (specify):                                    |
| Cartesian: Expanding:                | Lasing Species:                                       |
| KINETICS GRID DIMENSIONALITY (1):    | Number of Species: varial                             |
| 1-D:2-D:                             | Number of Reactions:                                  |
| 3-D:                                 | Other Major Species Considered:                       |
| GAIN REGION SYMMETRY RESTRICTIONS:   |   |
| Gain Vary Along Optical Axis:        |   |
| Flow Direction;                      | IMPACT EXCITATION MODELED ( ):                        |
| Flow Direction; CW:                  | (Reference)   |
| NUMERICAL SCHEME USED IN RATE        | Vibrational:  |
| CALCULATION (1):                     | Electronic:   |
| Explicit: V                          | Others (specify):                                     |
| Implicit:                            |   |
| Others (specify):                    | ENERGY TRANSFER MODES MODELED ( ): (Reference)        |
|                                      | V-T;  |
| REFERENCE OF METHOD USED:            | V-R:  |
|                                      | v-v: 🗸  |
|                                      | Others (specify):                                     |
| PLASMA KINETICS MODEL                | Lasing Transition: P-Branch: V                        |
| NUMBER OF SPECIES TREATED (specify): | R-Branch; V   |
| Number of Positive Species:          | Single Line Model (1):                                |
| Number of Negative                   | Multi-Line Model (1):                                 |
| Species: Number of Neutral           | Assumed Rotational Population Distribution State (√): |
| Species:                             | Equilibrium:  |
| REACTION MECHANISM MODELED ( ):      | Nonequilibrium:                                       |
| Primary lonization; (Reference)      | Number of Laser Lines. Modeled: Variable              |
| E-Beam:                              |   |
| Self-Sustained:                      | Source of Rate Coefficients Used in Code: SSH         |
| UV-Initiated:                        |   |
| Others (specify):                    | I IN E PROPERTY MODELS of                             |
|                                      | LINE PROFILE MODELS ( $$ ):                           |
| Secondary Ionization (Reference)     | Doppler Broadening:  Collisional Broadening:          |
| Attachment:                          |   |
| Detachment:                          | Others (specify):                                     |
| lon-lon Recom-<br>bination:          | 4. RECIRCULATION CONTAMINANTS                         |
| Charge Transfer:                     | MODELED (✓): none                                     |
| Dissociation/<br>Recombination;      | O <sub>X</sub> : OH <sub>X</sub> :                    |
| Others (specify):                    | NO <sub>x</sub> : HNO <sub>x</sub> :                  |
|                                      | Others (specify):                                     |
| Source of Rate Coefficients Used:    |   |
|                                      | REFERENCE FOR REACTION MECHANISM                      |
| DISCHARGE POWER INPUT MODELED ( ):   | AND RATES:  |
| Uniform: V Non-Uniform:              | OTHER UNIQUE FEATURES:                                |
| E-Field:                             |   |
| Others (specify):                    |   |

| DE NAME: FR  | EESL TECHNICAL AREA(S): Gas Dynamics   |
|--|--|
|  | NTS TREATED:Cavity-Beam Duct Interface   |
|  | OSE(S)/APPLICATION(S) OF CODE: Compute development of free shear layer   |
|  | of primary cavity flow and secondary injected beam duct flow,  |
| a confined   |  |
|  |  |
|  |  |
| SESSMENT OF C  | APABILITIES: Determines penetration of beam duct gas into cavity -   |
|  | CO <sub>2</sub> into beam duct - velocity and species concentration profiles   |
| cross shear  | layer and optical path difference.   |
|  |  |
| SESSMENT OF L  |  |
|  | tion of elliptic problem and is unknown within the context of the  |
|  | ar layer equations both zero shear and zero velocity boundary  |
|  | ed to bound problem.   |
| HER UNIQUE FE  | CATURES: Shear layer edge conditions determined through influence  |
|  | isplacement thickness on inviscid cavity flow. Unequal diffusion   |
| perricients t  | used in conjunction with binary diffusion approximation.   |
|  |  |
| IGINATOR/KEY   |  |
| Name: Pete   |  |
| Organization;  | RDA  |
| Address:   | ATO 9377 Int. Airport, Albuquerque, NM 87119   |
| Phone:505  | -844-3013  |
|  |  |
|  | MENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and   |
| RP = Related   | Publication):  |
| RP = Related   |  |
| RP = Related   | Publication):  |
| RP = Related   | Publication):  |
| RP = Related   | Publication):  |
| RP = Related T,L, RD   | Publication):  |
| RP = Related T,L , RD  | Publication): A Report No. 80-A/K-21-0.1143  |
| RP = Related T,L , RD.   | Publication): A Report No. 80-A/K-21-0.1143  Surrently?: yes   |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?:yes cation?:yes  |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version  |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?:yes cation?:yes  |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i uses   | Publication): A Report No. 80-A/K-21-0.1143  Surrently?:yes  sation?:yes s):tmproved turbulence model (2 eq. model) current version eddy viscosity model.  |
| RP = Related T,L , RD,  ATUS: Operational C Under Modific Purpose(i uses  Ownership?:  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?: yes tation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA   |
| RP = Related T,L , RDi  ATUS: Operational C Under Modific Purpose(i uses  Ownership?: Proprietary?:  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?:yes sation?:yes s):tmproved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no   |
| RP = Related T,L , RDi  ATUS: Operational C Under Modific Purpose(i uses  Ownership?: Proprietary?:  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?: yes tation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA   |
| ATUS: Operational C Under Modific Purpose(i uses  Ownership?: Proprietary?: ACHINE/OPERAT  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no HNG SYSTEM (on which installed): CRAY-1  |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i uses  Ownership?; Proprietary?; ACHINE/OPERAT  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no RING SYSTEM (on which installed): CRAY-1  Proved: Yes  |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i uses  Ownership?; Proprietary?; ACHINE/OPERAT  | Publication): A Report No. 80-A/K-21-0.1143  Surrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no HNG SYSTEM (on which installed): CRAY-1  |
| ATUS: Operational C Under Modific Purpose(i uses  Ownership?: Proprietary?: CHINE/OPERAT  ANSPORTABLE? Machine Depe  | Publication): A Report No. 80-A/K-21-0.1143  Gurrently?:yes cation?:yes s):tmproved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no ING SYSTEM (on which installed):CRAY-1  ?:yes endent Restrictions: none   |
| RP = Related T,L, RD.  ATUS: Operational C Under Modific Purpose(i uses  Ownership?: Proprietary?: CHINE/OPERAT  ANSPORTABLE? Machine Depe   | Publication): A Report No. 80-A/K-21-0.1143  Surrently?:yes  |
| RP = Related T,L, RD.  ATUS: Operational C Under Modific Purpose(i uses  Ownership?: Proprietary?: CHINE/OPERAT  ANSPORTABLE? Machine Depe   | Publication): A Report No. 80-A/K-21-0.1143  Gurrently?:yes cation?:yes s):tmproved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no ING SYSTEM (on which installed):CRAY-1  ?:yes endent Restrictions: none   |
| RP = Related T,L, RD.  ATUS: Operational C Under Modific Purpose(i uses  Ownership?: Proprietary?: CHINE/OPERAT  ANSPORTABLE? Machine Depe   | Publications: A Report No. 80-A/K-21-0.1143  Surrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no ING SYSTEM (on which installed):   |
| RP = Related T,L, RD.  ATUS: Operational C Under Modific Purpose(i uses  Ownership?: Proprietary?: CHINE/OPERAT  ANSPORTABLE? Machine Depe   | Publication): A Report No. 80-A/K-21-0.1143  Surrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no ING SYSTEM (on which installed):   |
| RP = Related T,L, RD.  ATUS: Operational C Under Modific Purpose(i USES  Ownership?: Proprietary?: ANSPORTABLE? Machine Depe  LF-CONTAINED? Other Codes F  | Publications: A Report No. 80-A/K-21-0.1143  Surrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no ING SYSTEM (on which installed):   |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i USES  Ownership?: Proprietary?: CHINE/OPERAT  ANSPORTABLE? Machine Depe  LF-CONTAINED? Other Codes F                                   | Publication):  A Report No. 80-A/K-21-0.1143  Sourcently?:   |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i USES  Ownership?: Proprietary?: ANSPORTABLE? Machine Depe LF-CONTAINED? Other Codes F  IMATE OF RES  Small Job; Typical Job;           | Publication): A Report No. 80-A/K-21-0.1143  Gurrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no HING SYSTEM (on which installed): CRAY-1  ?: yes cation?: yes cation?: yes None RDA NO  ROB SYSTEM (on which installed): CRAY-1  ?: yes cation?: yes cation?: yes None ROB NO ROB SYSTEM (on which installed): CRAY-1  Required (name, purpose): None Required (name, purpose): None SOURCES REQUIRED FOR RUNS: Core Size (Octal Words) Execution Time (sec, CDC 7600) |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i USES  Ownership?: Proprietary?: ANSPORTABLE? Machine Depe LF-CONTAINED? Other Codes F  IIMATE OF RES  Small Job: Large Job: Large Job: | Publication): A Report No. 80-A/K-21-0.1143  Furrently?:   |
| RP = Related T,L , RD;  ATUS: Operational C Under Modific Purpose(i USES  Ownership?: Proprietary?: ANSPORTABLE? Machine Depe LF-CONTAINED? Other Codes F  IIMATE OF RES  Small Job: Large Job: Large Job: | Publication): A Report No. 80-A/K-21-0.1143  Gurrently?: yes cation?: yes s): Improved turbulence model (2 eq. model) current version eddy viscosity model.  RDA no HING SYSTEM (on which installed): CRAY-1  ?: yes cation?: yes cation?: yes None RDA NO  ROB SYSTEM (on which installed): CRAY-1  ?: yes cation?: yes cation?: yes None ROB NO ROB SYSTEM (on which installed): CRAY-1  Required (name, purpose): None Required (name, purpose): None SOURCES REQUIRED FOR RUNS: Core Size (Octal Words) Execution Time (sec, CDC 7600) |

#### GAS DYNAMICS CODE

CODE NAME: FREESL I. CODE STRUCTURE DECONTAMINATION METHOD TREATED (1): COORDINATE SYSTEM ( ): Scrubber: Cartesian: Expanding: Y Shower: none FLUID GRID DIMENSIONALITY ( ): Catalytic Reactor: Others (specify): 2-D: V 3-D: Time Dependent: FLOW FIELD MODELED ( ): 4. ACOUSTIC ATTENUATION MODEL Compressible Flow: GENERAL FEATURES MODELED (√): Incompressible: Single Pulse: Repetitive Pulse: DIMENSIONALITY TREATED ( ): Viscous Flow: No Flow: 1-D:\_\_\_\_\_\_ 2-D:\_\_\_\_\_ 3-D:\_\_\_\_ BASIC MODELING APPROACH ( √): Time-Dependent: Algebraic: \_\_\_\_ Integral Method: \_\_ DISTURBANCE MODELED ( ): Finite Difference: Pressure Wave: \_\_\_\_ Entropy Wave: \_ Others (specify): Others (specify): REFERENCE FOR APPROACH USED: Thin WAVE PROPAGATION TREATMENT (√): Shear Layer equations Linear Wave: Nonlinear Wave: Others (specify): 2. GAS DYNAMICS MODEL FEATURES: GAS SUPPLY MODELED ( ): THEORETICAL BASIS: (Reference) Mixture Preparation: N,-CO,-He Mixture Injection: No Nozzles: NUMERICAL METHODOLOGY: (Reference) Flow Plates:
Others (specify): Beam duct injection into cavity is N2 ACOUSTIC ATTENUATORS CONSIDERED ( ): CAVITY INITIAL CONDITION DETERMINED Muffler: Heat Exchanger: BY (specify): assumed initial profiles Horn: Porous Wall: Others (specify): 3. EXHAUST/RECIRCULATION MODEL GENERAL SYSTEM MODELED ( ): 5. MODEL EFFECTS ON OPTICAL MODES DUE Open System: \_\_\_\_ Closed System: \_\_\_ TO (1): Index of Refraction Variation?; yes Closed Cycle: Other (specify): Optical path EXHAUST SYSTEM FEATURES ( ): Pressure Recovery: difference computed across Ejector System: shear layer Compressor/Fan: Heat Exchanger; OTHER UNIQUE FEATURES: \_\_ Gas Make-Up: Others (specify):\_

| DEVICE COMPO  | GALERK  | TEC  | HNICAL AREA(S):   | Electron I      | Cinetics        |             |
|---|---|--|---|-----------------|-----------------|-------------|
| DEVICE COMPO  | NENTS TREAT   |  |   |                 |                 |             |
| PRINCIPAL PUR   | POSE(S)/A PPI   | ICATION(S) OF  | ODE: To pred:   | ct electron     | transport       | and .       |
| excitation-   | ionization  | coefficients   | from cross-se   | ection data.    |                 |             |
|   |   |  |   |                 |                 |             |
|   |   |  |   |                 |                 |             |
|   |   | m 11   |   |                 |                 |             |
|   |   |  | first time pro  |                 |                 |             |
|   |   |  | ffects of larg  |                 | cross-sec       | tions,      |
| such as tha   | t for vibra   | tional excita  | ation of N <sub>2</sub> of  | - 00.           |                 |             |
|   |   | Dominos  | large computer  |                 | d onl., on (    | DAY T       |
|   |   |  | large computer id and to iter   |                 |                 |             |
| of ionizati   |   | to aujust 91.  | ta ana to Ite   | ace solution    | is in prese     | 31100       |
| 01 101112411  | O   |  |   |                 |                 |             |
| OTHER UNIONE  | PEATURES.   |  |   |                 |                 |             |
| OTHER UNIQUE  | FEATURES:_  |  |   |                 | <del></del>     |             |
|   |   |  |   |                 |                 |             |
|   |   |  |   |                 |                 |             |
| ORIGINATOR/KE   | Y CONTACT.  |  |   |                 |                 |             |
|   |   | tchford (original  | ginator)  |                 |                 |             |
|   |   | 28/80 J.I.L.A  |   | After 1/1/      | 81-Sandia 1     | Laboratorie |
|   |   | do, Boulder,   |   | Albuquerqu      |                 |             |
|   | 303) 492-82   |  |   |                 |                 |             |
| AVAILABLE DO  |   | N (Please specify,   | use T = Theory, t   | J = User's Manu | al, L = Listing | , and       |
|   |   |  | 7. O'Neil, V.I  | R. Rumble, J    | r.,             |             |
|   |   |  |   |                 |                 |             |
| rnys.   | TICA . VI (TI   | press) 1980.   | •   |                 |                 |             |
| Pnys.   | nev. n (1)  | press) 1980  | •   |                 |                 |             |
| - rnys.   | Nev. A (II  | press) 1980  | •   |                 |                 |             |
| - Pnys.   | Nev. A (II  | n press) 1980  | •   |                 |                 |             |
|   | Nev. 7 (2)  | press) 1980  | •   |                 |                 |             |
| STATUS:   |   |  |   |                 |                 |             |
| STATUS: Operationa  | Currently?:   |  | •   |                 |                 |             |
| STATUS: Operationa Under Mod  | Currently?;   >   | X  |   | ) using exte    | rnal memory     | y.          |
| STATUS: Operationa Under Mod  | Currently?;   >   | X  | on on CDC 7600  | ) using exte    | rnal memory     | y           |
| STATUS: Operationa Under Mod Purpos   | Currently?;   | X<br>(llow operation   | on on CDC 7600  |                 |                 |             |
| STATUS: Operationa Under Mod Purpos   | Currently?;   | X<br>(llow operation   |   |                 |                 |             |
| STATUS: Operationa Under Mod Purpos   | Currently?: ification?: se(s): To a   | X<br>(llow operation   | on on CDC 7600  |                 |                 |             |
| STATUS: Operationa Under Mod Purpo: Ownership   | Currently?:   | X<br>(<br>llow operation   | on on CDC 7600<br>aboratory Ast   |                 |                 |             |
| STATUS: Operationa Under Mod Purpo: Ownership   | Currently?:   | X<br>(llow operation   | on on CDC 7600<br>aboratory Ast   |                 |                 |             |
| STATUS: Operationa Under Mod Purpos Ownership Proprietar MACHINE/OPER   | Currently?:<br>  ification?:  | X<br>(<br>llow operation   | on on CDC 7600<br>aboratory Ast   |                 |                 |             |
| STATUS: Operationa Under Mod Purpos Ownership Proprietar MACHINE/OPER   | I Currently?:  ification?:  se(s):  TO a  7:  Joint Ir  y?:  ATING SYSTE  | X Allow operation Astitute of Land M (on which installing)   | on on CDC 7600<br>aboratory Ast   | rophysics un    | der suppor      |             |
| STATUS: Operationa Under Mod Purpos Ownership Proprietar MACHINE/OPER   | I Currently?:  ification?:  se(s):  TO a  7:  Joint Ir  y?:  ATING SYSTE  | X Allow operation Astitute of Land M (on which installing)   | on on CDC 7600<br>aboratory Asti  | rophysics un    | der suppor      |             |
| STATUS: Operationa Under Mod Purpos Ownership Proprietar MACHINE/OPER   | I Currently?:  ification?:  se(s):  TO a  7:  Joint Ir  y?:  ATING SYSTE  E?:  to of ependent Restr   | X Allow operation Astitute of Land M (on which installing)   | on on CDC 7600<br>aboratory Asti  | rophysics un    | der suppor      |             |
| Operationa Under Mod Purpos  Ownership Proprietar MACHINE/OPER  TRANSPORTABI Machine Do   | I Currently?: ification?: se(s): TO a  7: Joint Ir y?: ATING SYSTE LE?: to of ependent Restr  | X (Illow operation) Institute of Low M (on which install ther CRAY I's ictions:  | on on CDC 7600<br>aboratory Asti  | cophysics un    | der suppor      | t from AFAP |
| STATUS: Operationa Under Mod Purpos  Ownership Proprietar MACHINE/OPER  TRANSPORTABI Machine Do  SELF-CONTAINE Other Code   | I Currently?: ification?:  se(s): To a  7: Joint Ir y?: ATING SYSTE  LE?: to of ependent Restr  ED?: s Required (na   | X (Illow operationstitute of Lame of L | on on CDC 7600<br>aboratory Astr<br>(led): CRAY I                       | cophysics un    | der suppor      | t from AFAP |
| STATUS: Operationa Under Mod Purpos  Ownership Proprietar MACHINE/OPER  TRANSPORTABI Machine Do  SELF-CONTAINE Other Code   | I Currently?: ification?: se(s): To a  ?: Joint Ir y?: ATING SYSTE  EP: to of ependent Restr  ED?: es Required (na  | X (allow operation) (astitute of Lame  | on on CDC 7600 aboratory Astronomy (led): CRAY I                        | cophysics un    | der suppor      | t from AFAP |
| STATUS: Operationa Under Mod Purpos  Ownership Proprietar MACHINE/OPER  TRANSPORTABI Machine Do  SELF-CONTAINE Other Code   | I Currently?: ification?: se(s): To a  ?: Joint Ir y?: ATING SYSTE  EP: to of ependent Restr  ED?: es Required (na  | X (allow operation) (astitute of Lame  | on on CDC 7600<br>aboratory Astr<br>(led): CRAY I                       | cophysics un    | der suppor      | t from AFAP |
| STATUS: Operationa Under Mod Purpos  Ownership Proprietar MACHINE/OPER  TRANSPORTABI Machine Do  SELF-CONTAINE Other Code   | I Currently?: ification?: se(s): To a  ?: Joint Ir y?: ATING SYSTE  EP: to of ependent Restr  ED?: es Required (na  | X (allow operation) (astitute of Lame  | on on CDC 7600 aboratory Astronomics CRAY I  CRAY I  NS: Execution Time | (sec, CDC 7,00) | der suppor      | t from AFAP |
| STATUS: Operationa Under Mod Purpos  Ownership Proprietar MACHINE/OPER  TRANSPORTABI Machine Do  SELF-CONTAINE Other Code  ESTIMATE OF R  Small Job: Typical Jo             | i Currently?: ification?: se(s): TO a  7: Joint Ir y?: ATING SYSTE  E?: to of ependent Restr  ED?: s Required (na ESOURCES RE Core Size   | X (allow operation) (astitute of Lame  | on on CDC 7600 aboratory Astronomy (led): CRAY I                        | (sec, CDC 7,00) | der suppor      | t from AFAP |
| STATUS: Operationa Under Mod Purpor  Ownership Proprietar MACHINE/OPER  TRANSPORTABI Machine De  SELF-CONTAINE Other Code  ESTIMATE OF R  Small Job: Typical Job Large Job: | I Currently?: ification?: Se(s): TO a  To | X (allow operation)  A stitute of Land M (on which install ther CRAY I's ictions:  Ther CRAY I's ictions:  Ther CRAY I's ictions:  Ther CRAY I's ictions:  | aboratory Astronomics CRAY I  CRAY I  NS: Execution Time  5 sec. on (   | (sec, CDC 7,00) | der suppor      | t from AFAP |
| STATUS: Operationa Under Mod Purpor  Ownership Proprietar MACHINE/OPER  TRANSPORTABI Machine De  SELF-CONTAINE Other Code  ESTIMATE OF R  Small Job: Typical Job Large Job: | I Currently?: ification?: Se(s): TO a  To | X (allow operation)  A stitute of Land M (on which install ther CRAY I's ictions:  Ther CRAY I's ictions:  Ther CRAY I's ictions:  Ther CRAY I's ictions:  | on on CDC 7600 aboratory Astronomics CRAY I  CRAY I  NS: Execution Time | (sec, CDC 7,00) | der suppor      | t from AFAP |

|   | CODE NAME: GALERK                                     |
|---|---|
| CODE STRUCTURE                            | 3. LASING KINETICS MODEL                              |
| COORDINATE SYSTEM (√): NA                 | GENERAL (specify):                                    |
| Cartesian: Expanding:                     | Lasing Species:                                       |
| KINETICS GRID DIMENSIONALITY (1):         | Number of Species: 1 electrons                        |
| 1-D: 2-D:                                 | Number of Reactions:                                  |
| 3-D;                                      | Other Major Species Considered:                       |
| GAIN REGION SYMMETRY RESTRICTIONS:        | other Major Species Committee,                        |
| Gain Vary Along Optical Axis:             |   |
| Flow Direction:                           | IMPACT EXCITATION MODELED ( ):                        |
| KINETICS MODELED: Pulsed: CW:             | (Reference)   |
| NUMERICAL SCHEME USED IN RATE             | Vibrational:  |
| CALCULATION ( ):                          | Electronic:   |
| Explicit:                                 | Others (specify): Rotation                            |
| Implicit:                                 | Nota Cion   |
| Others (specify): Matrix inversion        | ENERGY TRANSFER MODES MODELED (1):                    |
|   | (Reference)   |
|   |   |
| REFERENCE OF METHOD USED: Pitchford et al | V-T:<br>V-R:  |
| Phys. Rev. A (in press) 1980              |   |
|   | Others (specify):                                     |
| PLASMA RINETICS MODEL                     | Lasing Transition: P-Branch:                          |
| NUMBER OF SPECIES TREATED (specify);      | R-Branch:   |
| Number of Positive                        | Single Line Model ( ):                                |
| Species:                                  | Multi-Line Model ( ):                                 |
| Number of Negative 1 electrons Species:   | Assumed Rotational Population Distribution State (√): |
| Species:                                  | Equilibrium:  |
| REACTION MECHANISM MODELED (1):           | Nonequilibrium:                                       |
| Primary Ionization: (Reference)           | Number of Laser Lines                                 |
| E-Beam:                                   | Modeled:  |
| Self-Sustained: V                         | Source of Rate Coefficients Used in Code;             |
| ('V-Initiated:                            |   |
| Others (specify):                         | LINE PROFILE MODELS (A). NA                           |
|   | ENTE PROPILE MODELS (V):                              |
| Secondary Ionization (Reference)          | Doppler Broadening:                                   |
| Attachment:                               | Collisional Broadening:                               |
| Detachment:                               | Others (specify):                                     |
| Ion-Ion Recom-                            |   |
| bination:                                 | 4. RECIRCULATION CONTAMINANTS                         |
| Charge Transfer;                          | MODELED (√): NA                                       |
| Dissociation/ Recombination:              | O <sub>N</sub> :OH <sub>X</sub> :                     |
| Others (specify): Collisional             | NO <sub>x</sub> : HNO <sub>x</sub> :                  |
| Ionization                                | Others (specify):                                     |
| Source of Rate Coefficients Used:         |   |
| Crossections from Phelps (unpublished)    |   |
| DISCHARGE POWER INPUT MODELED ( ):        | AND RATES:  |
| Uniform: V Non-Uniform:                   | o Tille and Iour and Tille                            |
| E-Fleld;                                  | OTHER UNIQUE FEATURES:                                |
| Others (specify):                         |   |
| · · · · · · · · · · · · · · · · · · ·     |   |

| CODE NAME: H   | GX80 TECHNICAL AREA(s): Kinetics   |
|--|--|
| DEVICE COMPONEN  | TS TREATED: laser/discharge cavity   |
| PRINCIPAL PURPOS   | E(S)/APPLICATION(S) OF CODE: Computation of laser/discharge properties   |
| in electricall   | y excited rare-gas halide and mercury-halide lasers.   |
|  |  |
|  |  |
| ASSESSMENT OF CA   | PABILITIES: Capable of quantitative calculation of excited   |
|  | densities and electric discharge properties.   |
|  |  |
|  |  |
| ASSESSMENT OF LIN  | MITATIONS: Restricted to spatially uniform, volume dominated   |
| media.   |  |
|  |  |
| OTHER UNIQUE FEA   | TURES:   |
| January Chingon 1 24   |  |
|  |  |
|  |  |
| ORIGINATOR/KEY C   |  |
|  | liam L. Nighan   |
| Organization:  | United Technologies Research Center MS 90  |
| Address: Ea  | st Hartford, CT 06108<br>3) 727-7596   |
|  |  |
| AVAILABLE DOCUM<br>RP = Related P  | ENTATION (Please specify, use T = Theory, U = User's Manual, I. = Listing, and ublication):L, RP   |
|  |  |
| 4  |  |
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|  |  |
| ETATUS.  |  |
|  | rrently?: y  |
| Operational Cu   | rrently?:xtion?:   |
| Operational Cu<br>Under Modifica   | tion?:   |
| Operational Cu<br>Under Modifica   |  |
| Operational Cu<br>Under Modifica   | tion?:   |
| Operational Cu Under Modifica Purpose(s) Ownership?:   | utrc   |
| Operational Cu<br>Under Modifica<br>Purpose(s)   | utrc   |
| Operational Cu- Under Modifica Purpose(s) Ownership?: Proprietary?:  | utrc   |
| Operational Cu- Under Modifica Purpose(s) Ownership?: Proprietary?: MACHINE/OPERATION  | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A   |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATIONSPORTABLE?:  | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A yes, FORTRAN  |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATIONSPORTABLE?:  | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A   |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATION TRANSPORTABLE?: Machine Dependent   | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN dent Restrictions: none   |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATION TRANSPORTABLE?: Machine Dependence: SELF-CONTAINED?:  | tion?:   |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATION TRANSPORTABLE?: Machine Dependence: SELF-CONTAINED?:  | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN dent Restrictions: none   |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATION TRANSPORTABLE?: Machine Dependence SELF-CONTAINED?: Other Codes Re  | tion?:  UTRC  yes  NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN  dent Restrictions: none  no * equired (name, purpose):   |
| Operational Cu- Under Modifica Purpose(s) Ownership?: Proprietary?: MACHINE/OPERATION TRANSPORTABLE?: Machine Dependence SELF-CONTAINED?: Other Codes Re   | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN dent Restrictions: NONE  no * equired (name, purpose):  |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATION TRANSPORTABLE?: Machine Dependence SELF-CONTAINED?: Other Codes Reserved  | tion?:  UTRC  yes  NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN  dent Restrictions: none  no * equired (name, purpose):   |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: Proprietary?: MACHINE/OPERATION  TRANSPORTABLE?: Machine Dependence SELF-CONTAINED?: Other Codes Received  ESTIMATE OF RESO                                     | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN dent Restrictions: NONE  no * equired (name, purpose):  |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: Proprietary?: MACHINE/OPERATI  TRANSPORTABLE?: Machine Dependence SELF-CONTAINED?: Other Codes Research ESTIMATE OF RESO Small Job: Typical Job:                | tion?:  UTRC  yes  NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN  dent Restrictions: none  no *  equired (name, purpose):  OURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)                 |
| Under Modifica Purpose(s)  Ownership?; Proprietary?; MACHINE/OPERATI  TRANSPORTABLE?: Machine Dependence SELF-CONTAINED?; Other Codes Re ESTIMATE OF RESO Small Job; Typical Job; Large Job;   | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN dent Restrictions: none no * equired (name, purpose): URCES REQUIRED FOR RUNS: Core Size (Octal Words)   Execution Time (sec, CDC 7600)  55K approximately 10 sec       |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATI  TRANSPORTABLE?: Machine Depend  SELF-CONTAINED?: Other Codes Re  ESTIMATE OF RESO  Small Job: Typical Job: Large Job: Approximate N            | UTRC yes  NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN dent Restrictions: none  no * equired (name, purpose):  CORE SIZE (Octal Words) Execution Time (sec, CDC 7600)  55K approximately 10 sec  umber of FORTRAN Lines: 1800 |
| Operational Cu- Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATI  TRANSPORTABLE?: Machine Depend  SELF-CONTAINED?: Other Codes Re  ESTIMATE OF RESO  Small Job: Typical Job: Large Job: Approximate N  COMMENTS: | UTRC yes NG SYSTEM (on which installed): UNIVAC 1100/81A  yes, FORTRAN dent Restrictions: none no * equired (name, purpose): URCES REQUIRED FOR RUNS: Core Size (Octal Words)   Execution Time (sec, CDC 7600)  55K approximately 10 sec       |

CODE NAME: HGX80

| GKINETICS MODEL  RAL (specify): asing Species:rare gas/mercury halide umber of Species: umber of Reactions: ther Major Species Considered: CT EXCITATION MODELED (√):  |
|--|
| asing Species:rare gas/mercury halide umber of Species: umber of Reactions: ther Major Species Considered:   |
| umber of Species: umber of Reactions: ther Major Species Considered:   |
| umber of Reactions: ther Major Species Considered:   |
| ther Major Species Considered:   |
|  |
| CT EXCITATION MODELED ( );   |
| CT EXCITATION MODELED (V):   |
|  |
| (Reference)  |
| ibrational:  |
| lectronic:   |
| thers (specify):   |
| (0)  |
| GY TRANSFER MODES MODELED (√):   |
| (Reference)  |
| -T:  |
| -R:  |
| -V:  |
| thers (specify):   |
| asing Transition: P-Branch;  |
| R-Branch:  |
| ingle Line Model (♥);  |
| lulti-Line Model ( ):  |
| Assumed Rotational Population Distribution State ( 1:  |
| Equilibrium:   |
| Nonequilibrium;  |
| Sumber of Laser Lines  |
| Modeled:   |
| ource of Rate Coefficients Used in Code:   |
|  |
|  |
| PROFILE MODELS (√):  |
| oppler Broadening:   |
| ollisional Broadening:   |
| thers (specify):   |
|  |
| RCULATION CONTAMINANTS   |
|  |
| LED (√)none  |
|  |
| CLED ( <b>√</b> ) none<br>  <sub>x</sub> : Ol <sup>2</sup> <sub>x</sub> :<br>O <sub>x</sub> : HNO <sub>x</sub> :   |
| ELED ( <b>√</b> )none<br>x:OH <sub>x</sub> :   |
| CLED ( <b>√</b> ) none<br>  <sub>x</sub> : Ol <sup>2</sup> <sub>x</sub> :<br>O <sub>x</sub> : HNO <sub>x</sub> :   |
| CLED ( $$ )none    x: Olf   x:   Ox: HNO   x:   thers (specify):   RENCE FOR REACTION MECHANISM  |
| CLED (√) none  x:OH <sub>x</sub> :  O <sub>x</sub> :HNO <sub>x</sub> :  thers (specify):   |
| CLED ( $\sqrt{)}$ mone $x^{:} _{x^{:}} _{x^{$ |
| CLED ( $$ )none    x'  |
|  |

| CODE NAME:    | ILLOPT               | TECHNICAL AREA(S):                | Optics                         |
|---------------|----------------------|-----------------------------------|--------------------------------|
|               |                      | Optical Systems                   |                                |
| PRINCIPAL PUR | POSE(S)/APPLICAT     | TION(S) OF CODE:                  |                                |
| Illumination  | on evaluation a      | and optimization.                 |                                |
|               |                      |                                   |                                |
|               |                      |                                   |                                |
|               |                      |                                   |                                |
| ASSESSMENT OF | CAPABILITIES:        |                                   |                                |
| Evaluates     | intensity patte      | erns of very general opti-        | cal systems.                   |
|               |                      |                                   |                                |
|               |                      |                                   |                                |
| ASSESSMENT OF | LIMITATIONS:         |                                   |                                |
| Geometrica    | l optics only,       | ray-tracing. no diffract          | ion.                           |
|               |                      |                                   |                                |
|               |                      |                                   |                                |
| OTHER UNIQUE  | FEATURES:            |                                   |                                |
|               |                      |                                   |                                |
|               |                      |                                   |                                |
|               |                      |                                   |                                |
| ORIGINATOR/KE | Y CONTACT:           |                                   |                                |
|               | Johanna Schrube      | en                                |                                |
|               | n: Westinghous       |                                   |                                |
| Address       | Pittsburgh, I        | PA 15235                          |                                |
| Phone:        | 412-256-3611         |                                   |                                |
|               |                      | ease specify, use T = Theory, U = | Heer's Manual I - Listing and  |
| RP = Relat    | ed Publication):     | ase specify, use I - Incory, 0 -  | Oser's Manual, L. Eisting, and |
| T: T. P.      | Vogl,et al., "S      | Semiautomatic design of i         | lluminating systems",          |
| Applied       | Optics 11 (19        | 72) 1087-1090.                    |                                |
|               |                      |                                   |                                |
|               |                      |                                   |                                |
|               |                      |                                   |                                |
| STATUS:       |                      |                                   |                                |
|               | Currently?: Ye       | es                                |                                |
| Uperational   | ification?: NO       |                                   |                                |
|               |                      | <del></del>                       |                                |
| Purpos        | se(s):               |                                   |                                |
|               |                      |                                   |                                |
|               | Markinghous          |                                   |                                |
|               | : Westinghous        | e                                 |                                |
|               | yº: Yes              | 1.1.                              |                                |
| UNIVAC 110    | ATING SYSTEM (on     | which installed):                 |                                |
|               |                      |                                   |                                |
|               | .E?:                 |                                   |                                |
| Machine De    | ependent Restriction | s: yes                            |                                |
|               | n. Yes               |                                   |                                |
| SELF-CONTAINE |                      |                                   |                                |
| Other Code    | es Required (name, p | purpose):                         |                                |
|               |                      |                                   |                                |
| ESTIMATE OF R | ESOURCES REQUIR      |                                   |                                |
|               | Core Size (Octa      |                                   | c, CDC 7600) (UNIVAC)          |
| Small Job:    | 90,000K              |                                   |                                |
| Typical Jo    | b;                   | 120                               |                                |
| Large Job:    |                      | 3600                              |                                |
| Approxima     | te Number of FORT    | RAN Lines:                        |                                |
| COMMENTS:     |                      |                                   |                                |
|               |                      |                                   |                                |
|               |                      |                                   |                                |

| . CODE STRUCTURE                          | CONVERGENCE ( <b>√</b> ):                             |
|---|---|
| BASIC TYPE (V):                           | Technique;  |
| Physical Optics:                          | Power Comparison:                                     |
| Geometrical:                              | Field Comparison:                                     |
| Constant Gain: Floating Gain:             | Others (specify):                                     |
| FIELD (POLARIZATION) REPRESENTATION (√):  | Acceleration Algorithms Used?:                        |
| Scalar:                                   | Technique:  |
|   | MULTIPLE EIGENVALUE/EIGENVECTOR                       |
| Vector:                                   | EXTRACTOR ALGORITHMS ( ):                             |
| COORDINATE SYSTEM (√):                    | Prony:  |
| Cartesian;                                | Others (specify):                                     |
| Expanding (specify):                      |   |
| TRANSVERSE GRID DIMENSIONALITY (specify): |   |
| One-Dimensional:                          | 3. RESONATOR MODELING FEATURES                        |
| Two-Dimensional:                          | GENERAL CAPABILITIES:                                 |
| FIELD SYMMETRY RESTRICTIONS?:             | StahiIity ( <b>√</b> ):                               |
|   | Stable Resonators:                                    |
| MIRROR SHAPE(S) ALLOWED ( ):              | Unstable Resonators:                                  |
| Square:                                   | Type ( <b>V</b> )                                     |
| Rectangular:                              | Standing Wave;  |
| Circular:                                 | Traveling Wave  |
| Elliptical:                               | (Ring):   |
| Strip:                                    | Reverse   |
| Arbitrary:                                | Traveling<br>Wave:                                    |
| CONFIGURATION FLEXIBILITY (1):            | Branch (1):   |
| Fixed, Single Resonator Geometry:         | Positive:   |
|   | Negative:   |
| Fixed, Multiple Resonator Geometries:     | Optical Element Models Included (1):                  |
|   | Flat Mirrors;   |
| Modular, Multiple Resonator Geometries:   | Spherical Mirrors:                                    |
|   | Cylindrical   |
| Others (describe): Arbitrary              | Mirrors:  |
|   | Telescopes:   |
|   | Scraper Mirrors:                                      |
| PROPAGATION TECHNIQUE                     | Deformable Mirrors:                                   |
| ( ail that apply):                        | Spatial Filters:                                      |
| Fresnel Integral Algorithms:              | Gratings (specify type):                              |
| With Kernel<br>Averaging:                 | Other Elements (specify):                             |
| Gaussian Quad-<br>rature:                 | PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List): |
| Fast Fourier Transform (FFT):             |   |
| Fast Hankel Trans-<br>form (FHT):         |   |
| Gardener-<br>Fresnel-                     |   |
| Kirchhoff (GFK):                          |   |
| Others (specify): Ray Trace               |   |
| Finite Difference                         |   |
| Algorithms                                |   |
| Method (specify):                         |   |

# OPTICS CODE

(Concluded)

CODE NAME: ILLOPT

|     | Simple Saturated Gain:                             |
|-----|--|
|     | Detailed Model (See<br>Section 3 in Kinetics Code) |
| BAF | RE CAVITY FIELD MODIFIER MODELS (                  |
|     | Mirror Tilt:                                       |
|     | Mirror Decentration:                               |
|     | Aberrations/Thermal Distortion:                    |
|     | Arbitrary:   |
|     | Selected (specify):                                |
|     | Reflectivity Loss:                                 |
|     | Output Coupler Edges                               |
|     | Rolled:  |
|     | Serrated:  |
|     | Other:   |
|     | DED CAVITY FIELD MODIFIER DELS (√):                |
|     | Refractive Index<br>Variation:                     |
|     | Gas Absorption:                                    |
|     | Overlapped Beams (for flux updating):              |
|     | Number of Overlaps<br>Allowed:                     |
|     | Others:  |
|     |  |
|     |  |
| FAF | FIELD MODELS (V):                                  |
|     | Beam Steering Removal:                             |
|     | Optimal Focal Search:                              |
|     | Beam Quality;                                      |
|     | Atmospheric Propagation<br>Effects:                |
|     | Others:  |
|     |  |
| BEA | M CONTROL SYSTEM MODELED (1):                      |
|     | Pointer/Tracker<br>Subsystem:                      |
|     | Beam Jitter:                                       |
|     | Autoalignment;                                     |
|     | Target Model:                                      |
|     | Motion: Effects:                                   |

|   | BOLTZ  | TECHNICAL ARE  | A(s): Kinet       | ics   |
|---|--|--|-------------------|---|
| DEVICE COMPONEN   | TS TREATED:  | NA TECHNICAL ARE   |                   |   |
| PRINCIPAL PURPOS  | E(S)/APPLICATION   | ON(S) OF CODE: Giver   | a set of rea      | actions and reaction<br>n levels in upper and         |
| rates, the code   | will comput  | e the time-depende   | nt population     | n levels in upper and                                 |
| lower states.   | A Boltzmann  | code is used to co   | mpute the rea     | action rates. Although                                |
| for other elem  | nercury-xenon  | , it is constructe   | d in a genera     | al tashion to allow                                   |
|   |  |  |                   |   |
| ASSESSMENT OF CA  | PABILITIES: V  | ery general and ve   | ry modular.       | If the desired reaction                               |
| are included,   | ind cross-sec  | tions for the gase   | s are availal     | ble, the code will                                    |
| carculate the   | . me-dependen  | t population level   | S.                |   |
|   | N/A  | METTER 22 1 F  | 7                 |   |
| ASSESSMENT OF LI  | WITATIONS: NA  | er out calculation   | input, thous      | gh this could be changed<br>must supply the equations |
| The code is bar   | sically a lin  | ear diff. eqn. sys   | tem colver        | must supply the equations                             |
|   | ,10011, 0 111  | - cqu. sys   | tem sorver.       |   |
|   | 11   | 1 1  |                   |   |
| OTHER UNIQUE FEA  | TURES: Very  | modular. The Bol   | tzmann code       | package and the                                       |
| checked for con   | rage can be  | changed with a mir<br>validity. Output                         | imum of code      | changes. Input is                                     |
| CHECKER TOT COL   | isistency and  | varialty. Output   | is very clea      | ir.   |
|   |  |  |                   |   |
| ORIGINATOR/KEY C  | ONTACT:<br>cy Happ   |  |                   |   |
| Name:   |  |  |                   |   |
| Organization:   | Tetra Corp   | SE, Albuquerque,   | NM 87108          |   |
|   |  | st, Arbuquerque,   | NM 07100          |   |
|   | 5) 256-3595  |  |                   |   |
| AVAILABLE DOCUM<br>RP = Related F   | ENTATION (Plea:  | se specify, use T = Theo                                       | ry, U = User's Ma | anual, I. = Listing, and                              |
|   |  | Xenon Kinetics Cod   | e (U)             |   |
|   |  | e upon request.  | <u>`</u>          |   |
|   |  |  |                   |   |
|   |  |  |                   |   |
|   |  |  |                   |   |
| STATUS:   |  |  |                   |   |
|   | rrently?. yes  |  |                   |   |
| Operational Cu  |  |  |                   |   |
| Operational Cu  | tion?.   |  |                   |   |
| Under Modifica  | tion?;   |  |                   |   |
|   |  |  |                   |   |
| Under Modifica  |  |  |                   |   |
| Under Modifica<br>Purpose(s   | ):   |  |                   |   |
| Under Modifica Purpose(s) Ownership?:   | U. S. Govern   |  |                   |   |
| Under Modifica Purpose(s  Ownership?; Proprietary?;   | U. S. Govern   | nment  | 6600 or 176       |   |
| Under Modifica Purpose(s) Ownership?:   | U. S. Govern   | nment  | 6600 or 176       |   |
| Under Modifica Purpose(s  Ownership?: Proprietary?: MACHINE/OPERATI   | U. S. Govern<br>No<br>NG SYSTEM (on w  | nment  | 6600 or 176       |   |
| Under Modifica Purpose(s  Ownership?;  Proprietary?;  MACHINE/OPERATI  TRANSPORTABLE?;  | U. S. Govern<br>No<br>NG SYSTEM (on w  | nment which installed): CDC                                    |                   | iollerith Characters                                  |
| Under Modifica Purpose(s  Ownership?;  Proprietary?;  MACHINE/OPERATI  TRANSPORTABLE?;  | U. S. Govern No NG SYSTEM (on w  | nment which installed): CDC                                    |                   | dollerith Characters.                                 |
| Ownership?: Proprietary?: MACHINE/OPERATI TRANSPORTABLE?: Machine Depen   | U. S. Govern No NG SYSTEM (on w  Almost dent Restrictions: is used.  | nment which installed): CDC                                    |                   | lollerith Characters.                                 |
| Ownership?: Proprietary?: MACHINE/OPERATI TRANSPORTABLE?: Machine Depen NAMELIST SELF-CONTAINED?:   | U. S. Govern No NG SYSTEM (on w  Almost dent Restrictions: is used.  | nment which installed):CDC Formats are A8                      | or AlO for I      |   |
| Ownership?: Proprietary?: MACHINE/OPERATI TRANSPORTABLE?: Machine Depen NAMELIST SELF-CONTAINED?: Other Codes R   | U. S. Govern No NG SYSTEM (on w  Almost dent Restrictions: is used.  | nment which installed):CDC Formats are A8                      |                   |   |
| Ownership?: Proprietary?: MACHINE/OPERATI TRANSPORTABLE?: Machine Depen NAMELIST SELF-CONTAINED?: Other Codes R with the  | U. S. Govern No NG SYSTEM (on w  Almost dent Restrictions: is used. equired (name, pu  | nment  which installed):CDC  Formats are A8  rpose):Runge-Kutt | or AlO for I      |   |
| Ownership?: Proprietary?: MACHINE/OPERATI TRANSPORTABLE?: Machine Depen NAMELIST SELF-CONTAINED?: Other Codes R   | U. S. Govern No NG SYSTEM (on w  Almost dent Restrictions: is used.  equired (name, pu e package.                                  | nment  which installed):CDC  Formats are A8  rpose):Runge-Kutt | or AlO for I      | . Can be supplied                                     |
| Ownership?: Proprietary?: MACHINE/OPERATI TRANSPORTABLE?: Machine Depen NAMELIST SELF-CONTAINED?: Other Codes R with the  | U. S. Govern No NG SYSTEM (on w  Almost dent Restrictions: is used. equired (name, pu  | nment  which installed):CDC  Formats are A8  rpose):Runge-Kutt | or AlO for I      | . Can be supplied                                     |
| Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATI  TRANSPORTABLE?: Machine Depen NAMELIST  SELF-CONTAINED?: Other Codes R with the ESTIMATE OF RESC                          | U. S. Govern No NG SYSTEM (on w  Almost dent Restrictions: is used.  equired (name, pu e package.                                  | nment  which installed):CDC  Formats are A8  rpose):Runge-Kutt | or AlO for I      | . Can be supplied                                     |
| Under Modifica Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERATI  TRANSPORTABLE?: Machine Depen NAMELIST  SELF-CONTAINED?: Other Codes R with the ESTIMATE OF RESC  Small Job: Typical Job: | U. S. Govern No NG SYSTEM (on w  Almost dent Restrictions: is used. equired (name, pu e package. DURCES REQUIRE Core Size (Octal v | nment  which installed):CDC  Formats are A8  rpose):Runge-Kutt | or AlO for I      | . Can be supplied                                     |
| Ownership?: Proprietary?: Proprietary?: MACHINE/OPERATI TRANSPORTABLE?: Machine Depen NAMELIST SELF-CONTAINED?: Other Codes R. with the ESTIMATE OF RESC Small Job: Typical Job: Large Job:     | U. S. Govern No NG SYSTEM (on w Almost dent Restrictions: is used. equired (name, pu e package.  DURCES REQUIRE Core Size (Octal v | rpose): Runge-Kutt  D FOR RUNS: Words) Execution T             | or AlO for I      | Can be supplied                                       |
| Ownership?: Proprietary?: Proprietary?: MACHINE/OPERATI TRANSPORTABLE?: Machine Depen NAMELIST SELF-CONTAINED?: Other Codes R. with the ESTIMATE OF RESC Small Job: Typical Job: Large Job:     | U. S. Govern No NG SYSTEM (on w Almost dent Restrictions: is used. equired (name, pu e package.  DURCES REQUIRE Core Size (Octal v | rpose): Runge-Kutt  D FOR RUNS: Words) Execution T             | or AlO for I      | . Can be supplied                                     |

CODE NAME: KINBOLTZ

| 1. CODE STRUCTURE                           | 3. LASING KINETICS MODEL                               |  |  |
|---|--|--|--|
| COORDINATE SYSTEM (√):                      | GENERAL (specify):                                     |  |  |
| Cartesian: Expanding:                       | Lasing Species: <u>User-defined</u>                    |  |  |
| KINETICS GRID DIMENSIONALITY (1):           | Number of Species: user-defined                        |  |  |
| 1-D: \(\sum_{}\) 2-D: \(\)                  | Number of Reactions: User-defined                      |  |  |
| 3-D:  | Other Major Species Considered:                        |  |  |
| GAIN REGION SYMMETRY RESTRICTIONS:          | Other Major Species Considered;                        |  |  |
| Gain Vary Along Optical Axis:               |  |  |  |
| Flow Direction:                             | INDICT FUCITION MODEL FR                               |  |  |
| KINETICS MODELED: Pulsed: V CW;             | IMPACT EXCITATION MODELED (√):                         |  |  |
| NUMERICAL SCHEME USED IN RATE               | (Reference)  Vibrational: (user-define)                |  |  |
| CALCULATION (1):                            | 7 11 11  |  |  |
| Explicit: V                                 | Electronic:  |  |  |
| Implicit:                                   | Others (specify):                                      |  |  |
| Others (specify):                           |  |  |  |
|   | ENERGY TRANSFER MODES MODELED ( ):                     |  |  |
|   | (Reference)  |  |  |
| REFERENCE OF METHOD USED: Thomson,          | V-T: vuser-defined                                     |  |  |
| Smith & Davies, "Boltz: A code",            | V-R: / " "   |  |  |
| Computer Phys. Comm., V.11, p. 369-38       | 3, 1976 V-V: V " "                                     |  |  |
|   | Others (specify):                                      |  |  |
| 2. PLASMA KINETICS MODEL                    | Lasing Transition: P-Branch:                           |  |  |
| NUMBER OF SPECIES TREATED (specify);        | R-Branch;  |  |  |
| Number of Positive<br>Species: user-defined | Single Line Model (♥):                                 |  |  |
| Number of Negative # #                      | Multi-Line Model (√):                                  |  |  |
| Species:                                    | Assumed Rotational Population                          |  |  |
| Number of Neutral # # # Species:            | Distribution State (√):                                |  |  |
| REACTION MECHANISM MODELED (√):             | Equilibrium:   |  |  |
| Primary Ionization: (Reference)             | Nonequilibrium:  |  |  |
| E-Beam: V   User-defined                    | Number of Laser Lines<br>Modeled:                      |  |  |
| Self-Sustained: / H                         | Source of Rate Coefficients Used in Code:              |  |  |
| UV-initiated:                               |  |  |  |
| Others (specify):                           |  |  |  |
|   | LINE PROFILE MODELS ( 1:                               |  |  |
| Secondary Ionization (Reference)            | Doppler Broadening:                                    |  |  |
| Attachment: User-defined                    | Collisional Broadening:                                |  |  |
| Detachment:                                 | Others (specify):                                      |  |  |
| Ion-Ion Recom-<br>bination:                 |  |  |  |
| Charge Transfer:                            | 4. RECIRCULATION CONTAMINANTS                          |  |  |
| Dissociation/                               | MODELED (√):   |  |  |
| Recombination:                              | O <sub>x</sub> : OH <sub>x</sub> :                     |  |  |
| Others (specify):                           | NO <sub>x</sub> : HNO <sub>x</sub> : Others (specify): |  |  |
| Source of Rate Coefficients Used: The user  |  |  |  |
| is responsible for providing the coef       | ficientREFERENCE FOR REACTION MECHANISM                |  |  |
| DISCHARGE POWER INPUT MODELED (V):          | AND RATES:   |  |  |
| Uniform: V Non-Uniform:                     |  |  |  |
|   | OTHER UNIQUE FEATURES:                                 |  |  |
|   | OTHER OWNERS I BATTIMES                                |  |  |
| E-Field: Others (specify):                  | OTHER OWIGED I ENTERING                                |  |  |

| CODE NAME:                   | KINETIC                                 | TECHNICAL AREA(S):  | Kinetics   |
|------------------------------|---|---|--|
| DEVICE COMPO                 | NENTS TREATED:                          | None  |  |
| PRINCIPAL PUR<br>kinetics c  | POSE(S)/APPLICATI<br>alculations for    | ON(S) OF CODE: This code<br>e-beam pumped lasers (i         | e is used for basic laser<br>It can treat discharge                            |
| lasers als                   | 5).                                     |   |  |
|                              |   |   |  |
|                              |   |   |  |
| Maxwellian                   | electron distr:                         | ibution (Te computed int                                    | culations using either a ternally) or with an electron the Boltzmann equation. |
| It will al                   | so perform ampli                        | fier calculations.  |  |
| ASSESSMENT OF                | LIMITATIONS                             |   |  |
| ADDEDDING: O                 |   |   | 7  |
|                              |   |   |  |
|                              |   |   |  |
|                              | FEATURES: The ceractive) output         |   | graphics (some of which  |
|                              |   |   |  |
| ORIGINATOR/KE                | Y CONTACT:                              |   |  |
| Name:                        | W. Lowell Morga                         | an  |  |
| Organizatio                  | n: Lawrence I                           | Livermore Laboratory  |  |
|                              |   | 2, Livermore, CA 94505                                      | 5  |
|                              | 415) 422-6289                           |   |  |
| AVAILABLE DOO<br>RP = Relate | UMENTATION (Pleated Publication);       | se specify, use T = Theory, U =<br>n general, none, I'll pr | User's Manual, L = Listing, and covide a listing                               |
|                              |   |   |  |
|                              |   |   | Information Center Report  |
| #19,                         | Univ. of Colors                         | ado, Boulder, CO.   |  |
|                              |   |   |  |
|                              |   |   |  |
| STATUS:                      |   |   |  |
|                              | Currently?: yes                         |   |  |
|                              |   | so as time goes on  |  |
| Purpos                       | e(s):                                   |   |  |
|                              |   |   |  |
| Ownership                    | · · · · · · · · · · · · · · · · · · ·   |   |  |
|                              | y?:                                     |   |  |
|                              | ATING SYSTEM (on                        | which installed): CRAY 1A                                   |  |
| TRANSPORTABL                 | E?: perhaps                             |   |  |
|                              |   | core size and run ti  | me, as the code is optimized   |
|                              | ctor calculation                        |   |  |
| SELF-CONTAINE                | D?:                                     |   |  |
| Other Code<br>a tab          | s Required (name, pu<br>le of rates vs. | electron temperature.                                       | cross-section data to create   |
| ESTIMATE OF R                | ESOURCES REQUIRE                        | ED FOR RUNS:  |  |
|                              | Core Size (Octal                        | Words)   Execution Time (se                                 | ec, CDC 7600)  |
| Small Job:                   |   |   |  |
| Typical Jo                   |   |   |  |
| Large Job;                   | 260K decim                              | al 60 sec CRAY  | 12 min /600**  |
| Approxima                    | te Number of FORTR                      | AN Lines: 5500  |  |
| (this is t                   | * The kinetics of the Maxwellian v      | only takes a few seconds<br>ersion) ** This is the          | s, the remainder is graphics<br>version that includes solution                 |
| of the Bol                   | tzmann equation                         | for electrons.  |  |

CODE NAME: KINETIC

| I. CODE STRUCTURE                                | 3. LASING KINETICS MODEL we have studied     |
|--|--|
| COORDINATE SYSTEM (√):                           | GENERAL (specify): Xe, KrF, ArF,             |
| Cartesian: Expanding:                            | Lasing Species: anything: Xef, Xe Cl         |
| KINETICS GRID DIMENSIONALITY ( ):                | Number of Species:30                         |
| I-D: <u>V</u> 2-D:                               | Number of Reactions: 100                     |
| 3-D:   | Other Major Species Considered:              |
| GAIN REGION SYMMETRY RESTRICTIONS:               |  |
| Gain Vary Along Optical Axis:                    |  |
| Flow Direction;                                  | IMPACT EXCITATION MODELED (♥):               |
| KINETICS MODELED: Pulsed: V CW:                  | (Reference)                                  |
| NUMERICAL SCHEME USED IN RATE                    | Vibrational:                                 |
| CALCULATION ( ):                                 | Electronic:                                  |
| Explicit:  | Others (specify):                            |
| Implicit: V                                      |  |
| Others (specify):                                | ENERGY TRANSFER MODES MODELED ( ):           |
|  | (Reference)                                  |
| Cana   | V-T; _ 🗸                                     |
| REFERENCE OF METHOD USED: Gear                   | V-R:   |
|  | V-V: 🗸                                       |
|  | Others (specify):                            |
| 2. PLASMA KINETICS MODEL                         | Lasing Transition: P-Branch:                 |
| MUMBER OF SPECIES TREATED (specify):             | R-Branch;                                    |
| Number of Positive Species: Arbitrary            | Single Line Model (1):                       |
| Number of Negative                               | Multi-Line Model ( ):                        |
| Species:   | Assumed Rotational Population                |
| Number of Neutral<br>Species:                    | Distribution State ( ):                      |
| REACTION MECHANISM MODELED (1):                  | Equilibrium: V                               |
| Primary Ionization: (Reference)                  | Nonequilibrium:                              |
| E-Beam:  | Number of Laser Lines<br>Modeled:            |
| Self-Sustained:                                  | Source of Rate Coefficients Used in Code;    |
| UV-Initiated:                                    |  |
| Others (specify): fission fragments              |  |
|  | LINE PROFILE MODELS ( ):                     |
| Secondary Ionization (Reference)                 | Doppler Broadening:                          |
| Attachment:                                      | Collisional Broadening:                      |
| Detachment:                                      | Others (specify):                            |
| lon-Ion Recom-                                   |  |
| bination:  Charge Transfer:                      | 4. RECIRCULATION CONTAMINANTS                |
| Dissociation/                                    | MODELED ( <b>√</b> ): none                   |
| Dissociation/<br>Recombination:                  | O <sub>x</sub> :                             |
| Others (specify)                                 | NO <sub>x</sub> :                            |
|  | Others (specify):                            |
| Source of Rate Coefficients Used: cross sections | REFERENCE FOR REACTION MECHANISM             |
| DISCHARGE POWER INPUT MODELED (V):               | AND RATES:                                   |
| Uniform; V Non-Uniform;                          |  |
| E-Field: V                                       | OTHER UNIQUE FEATURES: The code is very      |
| Others (specify):                                | general, all information concerning specific |
| Cyners (specify);                                | problems is in the data set.                 |
|  |  |
|  |  |

| CODE NAME: KRF  |   | TECHNICAL  | AREA(S): K    | ineti | lcs     |          |             |
|---|---|--|---------------|-------|---------|----------|-------------|
| DEVICE COMPONENTS TR  | EATED:  |  |               |       |         |          |             |
| PRINCIPAL PURPOSE(S)/A  | PPLICATION(S)   | OF CODE:   | Modeling      | KRF   | laser   | s and    | amplifier   |
|   |   |  | <del></del>   |       |         |          |             |
|   |   |  |               |       |         |          |             |
|   |   |  |               |       |         |          |             |
| ASSESSMENT OF CAPABI  | LITIES: Handl   | es gas der   | osition, I    | kinet | tics,   | absor    | otion, las  |
| in Fabry-Perot cavi   |   |  |               |       |         |          |             |
|   |   |  |               |       |         |          |             |
|   |   |  |               |       |         |          |             |
| ASSESSMENT OF LIMITAT   | NONS: Speci   | fic code   | for KRF       |       |         |          |             |
|   |   |  |               |       |         |          |             |
|   |   | ······   |               |       |         |          | · · ·       |
| OTHER UNIQUE FEATURE  |   |  |               | -     |         |          |             |
|   |   |  |               |       |         |          |             |
|   |   |  |               |       |         |          |             |
|   |   |  |               |       |         |          |             |
| ORIGINATOR/KEY CONTA  |   | •  |               |       |         |          |             |
| Name: Jeanette  |   |  | <del> </del>  |       |         |          |             |
| Organization: TRI Address: 1 Space  |   | do Beach   | CA 9027       | R     |         |          |             |
| Phone: 213-536-   | 453   | do Beach,  | CA 3027       |       |         |          |             |
|   |   |  |               | 111   |         |          |             |
|   | TION (Please spe  | ecify use T -  | Theory II -   |       | Manua   | 1 7 - 1  | isting and  |
| AVAILABLE DOCUMENTA<br>RP = Related Publica   | TION (Please spetion):  | ecify, use T =   | Theory, U = ' | User  | Manua   | l, L = I | isting, and |
| AVAILABLE DOCUMENTA   | tion):  |  |               |       | 3 Manua | l, L = I | isting, and |
| AVAILABLE DOCUMENTA<br>RP = Related Publica   | tion):  |  |               |       | s Manua | l, L ≈ I | isting, and |
| AVAILABLE DOCUMENTA<br>RP = Related Publica   | tion):  |  |               |       | s Manua | l, L ≈ I | isting, and |
| AVAILABLE DOCUMENTA<br>RP = Related Publica   | tion):  |  |               |       | s Manua | I, L = I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  | tion):  |  |               |       | s Manua | l, L ≈ I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L STATUS:  | tion):  |  |               |       | s Manua | I, L ≈ I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L STATUS: Operational Currentl   | y <sup>2</sup> : Yes  |  |               |       | s Manua | l, L = I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?:   | y?: Yes yes   |  |               |       | s Manua | l, L = 1 | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?:   | y <sup>2</sup> : Yes  |  |               |       | 5 Manua | I, L = I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?:   | y?: Yes yes   |  |               |       | s Manua | I, L = I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Ownership?: TRW   | y?: Yes yes   |  |               |       | s Manua | I, L = I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Ownership?: TRW Proprietary?: yes   | y?: Yes yes -developed ur   | nder IR&D  |               |       | s Manua | I, L ≈ I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Ownership?: TRW   | y?: Yes yes -developed ur   | nder IR&D  |               |       | 5 Manua | l, L ≈ I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Purpose(s): TRW Proprietary?: Yes MACHINE/OPERATING SY  | y?: Yes yes  -developed ur STEM (on which   | nder IR&D  |               |       | 5 Manua | I, L = I | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Purpose(s): TRAMSPORTABLE?: Y   | y?: Yes yes  yes  developed under the state of the state | nder IR&D  | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Purpose(s): TRW Proprietary?: Yes MACHINE/OPERATING SY  | y?: Yes yes  yes  developed under the state of the state | nder IR&D  | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Ownership?: TRW Proprietary?: Yes MACHINE/OPERATING SY TRANSPORTABLE?: Y Machine Dependent R  | y?: Yes yes yes  developed un STEM (on which es estrictions:  | nder IR&D  | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s):  Ownership?: TRW Proprietary?: Yes MACHINE/OPERATING SY  TRANSPORTABLE?: Y Machine Dependent R  SELF-CONTAINED?: Yes  | y?: Yes yes  -developed ur STEM (on which es estrictions:   | nder IR&D  | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Ownership?: TRW Proprietary?: Yes MACHINE/OPERATING SY TRANSPORTABLE?: Y Machine Dependent R  | y?: Yes yes  -developed ur STEM (on which es estrictions:   | nder IR&D  | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s):  Ownership?: TRW Proprietary?: Yes MACHINE/OPERATING SY  TRANSPORTABLE?: Y Machine Dependent R  SELF-CONTAINED?: Yes  | y?: Yes yes  yes  -developed un STEM (on which es estrictions: s d (name, purpose   | nder IR&D installed): ):                                   | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s):  Ownership?: TRW Proprietary?: Yes MACHINE/OPERATING SY TRANSPORTABLE?: Y Machine Dependent R  SELF-CONTAINED?: Other Codes Require   | y?: Yes yes  yes  -developed un STEM (on which es estrictions: s d (name, purpose   | nder IR&D installed):  : : : : : : : : : : : : : : : : : : | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Purpose(s):  Ownership?: TRW Proprietary?: yes MACHINE/OPERATING SY  TRANSPORTABLE?: Y Machine Dependent R  SELF-CONTAINED?: yes Other Codes Require  ESTIMATE OF RESOURCE Core:                              | y?: Yes yes yes  -developed un STEM (on which es estrictions: s d (name, purpose  | nder IR&D installed):  : : : : : : : : : : : : : : : : : : | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Purpose(s):  Ownership?: TRW Proprietary?: Yes MACHINE/OPERATING SY  TRANSPORTABLE?: Machine Dependent R  SELF-CONTAINED?: Other Codes Require  ESTIMATE OF RESOURCE Small Job: Typical Job:                  | y?: Yes yes yes  -developed un STEM (on which es estrictions: s d (name, purpose S REQUIRED FO Size (Octal Words  | nder IR&D installed):  : : : : : : : : : : : : : : : : : : | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Purpose(s):  Ownership?: TRW Proprietary?: Yes MACHINE/OPERATING SY  TRANSPORTABLE?: Y Machine Dependent R  SELF-CONTAINED?: Yes Other Codes Require  ESTIMATE OF RESOURCE Small Job: Typical Job: Large Job: | y?: Yes yes yes  -developed un STEM (on which es estrictions: S d (name, purpose S REQUIRED FO Size (Octal Words  | nder IR&D installed):  IR RUNS:  IR RUNS:  IR ALL SE       | CDC Cyber     | 174   |         |          | isting, and |
| AVAILABLE DOCUMENTA RP = Related Publica L  STATUS: Operational Currentl Under Modification?: Purpose(s): Purpose(s):  Ownership?: TRW Proprietary?: Yes MACHINE/OPERATING SY  TRANSPORTABLE?: Machine Dependent R  SELF-CONTAINED?: Other Codes Require  ESTIMATE OF RESOURCE Small Job: Typical Job:                  | y?: Yes yes yes  -developed un STEM (on which es estrictions: S d (name, purpose S REQUIRED FO Size (Octal Words  | nder IR&D installed):  IR RUNS:  IR RUNS:  IR ALL SE       | CDC Cyber     | 174   |         |          | isting, and |

|  | CODE NAME: KRF   |
|--|--|
| CODE STRUCTURE   | 3. LASING KINETICS MODEL                               |
| COORDINATE SYSTEM ( ):                                       | GENERAL (specify):                                     |
| Cartesian: Expanding:  | Lasing Species: KrF                                    |
| KINETICS GRID DIMENSIONALITY (1):                            | Number of Species: 24                                  |
| 1-D: 2-D:  | Number of Reactions: 92                                |
| 3-D:   | Other Major Species Considered: Ar , Arl               |
| GAIN REGION SYMMETRY RESTRICTIONS:                           | F, Ar, Kr, F   |
| Gain Vary Along Optical Axis:                                | 1 / 112 / 12   |
| Flow Direction:  | IMPACT EXCITATION MODELED (♥):                         |
| KINETICS MODELED: Pulsed: V CW:                              | •  |
| NUMERICAL SCHEME USED IN RATE                                | (Reference)  |
| CALCULATION ( ):   | Vibrational:   |
| Explicit;  | Electronic:  |
| Implicit:  | Others (specify):                                      |
| Others (specify):  |  |
|  | ENERGY TRANSFER MODES MODELED ( ):                     |
|  | (Reference)  |
| REFERENCE OF METHOD USED:                                    | V-T:   |
| Modified Trainor   | V-R:   |
|  | V-V:   |
| PLASMA KINETICS MODEL  | Others (specify):                                      |
| NUMBER OF SPECIES TREATED (specify):                         | Lasing Transition: P-Branch:                           |
| Number of Positive   | R-Branch;  |
| Species: 6   | Single Line Model (V):                                 |
| Number of Negative   | MultI-Line Model (√):                                  |
| Species: 1 Number of Neutral                                 | Assumed Rotational Population Distribution State ( 1): |
| Species: 17  | Equilibrium:   |
| REACTION MECHANISM MODELED ( 1:                              | Nonequilibrium:  |
| Primary ionization: (Reference)                              | Number of Laser Lines                                  |
| E-Beam:  | Modeled:   |
| Seif-Sustained:  | Source of Rate Coefficients Used in Code:              |
| UV-initiated:  |  |
| Others (specify):  | LINE PROFILE MODELS ( );                               |
| Secondary Ionization (Reference)                             | Duppler Broadening:                                    |
| Attachment:  | Collisional Broadening:                                |
| Detachment:  | Others (specify);                                      |
| Ion-Inn Recom-   |  |
| bination:  |  |
| Charge Transfer:   | 4. RECIRCULATION CONTAMINANTS                          |
| Dissociation/  | MODELED (√):   |
| Recombination:   | O <sub>X</sub> :OH <sub>X</sub> :                      |
| Others (specify):  | NO <sub>x</sub> : HNO <sub>x</sub> : Others (specify): |
| Source of Rate Coefficients Used: literature-several sources | REFERENCE FOR REACTION MECHANISM                       |
| DISCHARGE POWER INPUT MODELED (V):                           | AND RATES:   |
| Uniform; Non-Uniform;  | OTHER UNIQUE PEATURES.                                 |
|  | OTHER UNIQUE FEATURES:                                 |
| E-Field:   |  |

| CODE NAME:     | LAGAD                | TECHNICAL AREA(S): Gas Dynamics  |
|----------------|----------------------|--|
| DEVICE COMPON  | ENTS TREATED:        | Laser Cavity & Flow Loop   |
|                |                      | ION(S) OF CODE: Compute non-steady gas dynamics  |
| resulting fr   | om discharge he      | eating & flow loop heat exchanger & blower   |
| requirements   |                      |  |
|                |                      |  |
|                |                      |  |
| ASSESSMENT OF  | CAPABILITIES: F      | ast running - computes initial conditions using  |
|                |                      | ropagation by method of characteristics.   |
|                |                      |  |
|                |                      |  |
| ASSESSMENT OF  | LIMITATIONS: Co      | nstant gas properties, i.e. Cp, Cv, 3  |
|                |                      |  |
|                |                      | ·  |
|                |                      |  |
| OTHER UNIQUE E | EATURES: Calc        | omp Plot of Wave Diagram   |
|                |                      | · · · · · · · · · · · · · · · · · · ·  |
|                |                      |  |
|                |                      | 16   |
| ORIGINATOR/KE  | V CONTACT.           |  |
|                | rtin J. Pecher       | cky  |
|                | n: Westinghouse      |  |
|                | 310 Beulah Roa       |  |
|                | 12-256-7353          | u, rg., r  |
|                |                      | 7' The state of th |
|                | d Publication):      | ase specify, use T = Theory, U = User's Manual, L = Listing, and   |
|                |                      | ary, no other documentation  |
|                |                      |  |
|                |                      |  |
|                |                      |  |
|                |                      |  |
|                |                      |  |
| STATUS:        |                      |  |
|                | Currently?: Yes      |  |
|                | fication :           |  |
| Putpos         | e(s);                |  |
|                |                      |  |
|                |                      |  |
| Ownership      | Westinghou           | se   |
| Proprietary    | ?: Yes               |  |
| MACHINE/OPERA  | ATING SYSTEM (on     | which installed): UNIVAC-1108  |
|                |                      |  |
| TRANSPORTABL   | F?: yes              | Mr makening-religionis March   |
| Machine De     | pendent Restrictions | i:   |
|                |                      |  |
| SELF-CONTAINE  | D: Yes               |  |
| Other Codes    | Required (name, pr   | urpose);   |
|                |                      |  |
| ESTIMATE OF RI | ESOURCES REQUIR      | ED FOR RUNS:   |
|                | Core Size (Octal     |  |
| Small Job:     |                      |  |
| Typical Job    | 22411                | 17 sec - UNIVAC-1108   |
|                | : _22411             | 1/ Sec - UNIVACTION  |
| Large Job:     | - Number of CORDS    | RAN Lines: 800   |
|                | e Number of FCRTR    | (AN Lines: OUC   |
| COMMENTS:      |                      |  |
|                |                      |  |
|                |                      |  |

CODE NAME: LAGAD I. CODE STRUCTURE DECONTAMINATION METHOD TREATED (√): COORDINATE SYSTEM ( ): Scrubber: Cartesian: \_\_\_\_ Expanding: Shower: FLUID GRID DIMENSIONALITY ( ): Catalytic Reactor: I-D: \_\_\_\_ Others (specify): 3-D: Time Dependent: FLOW FIELD MODELED (√): 4. ACOUSTIC ATTENUATION MODEL Compressible Flow: GENERAL FEATURES MODELED (√): Incompressible: Single Pulse: V Repetitive Pulse: Viscous Flow: DIMENSIONALITY TREATED ( ): No Flow: I-D: 2-D: 3-D: BASIC MODELING, APPROACH ( √): Time-Dependent: Algebraic: \_\_\_ Integral Method: \_\_ DISTURBANCE MODELED ( ): Finite Difference: Pressure Wave: V Entropy Wave: Others (specify): Method of Charistics Others (specify): Hot gas clearing\* WAVE PROPAGATION TREATMENT ( ): REFERENCE FOR APPROACH USED: Text's of Shapiro & Rudinger Linear Wave: Nonlinear Wave: \_\_\_\_\_\_\_\_ Others (specify): 2. GAS DYNAMICS MODEL FEATURES: GAS SUPPLY MODELED (V): THEORETICAL BASIS: (Reference) Mixture Preparation: Mixture Injection: Nozzles: NUMERICAL METHODOLOGY: (Reference) Flow Plates: Others (specify): \_\_\_\_ ACOUSTIC ATTENUATORS CONSIDERED ( 1: CAVITY INITIAL CONDITION DETERMINED Muffler: Heat Exchanger: BY (specify): Code Horn: \_\_\_\_ Porous Wall: \_\_\_ Others (specify): 3. EXHAUST/RECIRCULATION MODEL GENERAL SYSTEM MODELED (√): 5. MODEL EFFECTS ON OPTICAL MODES DUE TO ( $\sqrt{\phantom{1}}$ ): Open System: Closed System: Closed Cycle: Index of Refraction Variation?: EXHAUST SYSTEM FEATURES ( ): Other (specify): Pressure Recovery: Ejector System: Compressor/Fan: Heat Exchanger: OTHER UNIQUE FEATURES: \_\_ \*Auxillary code to compute Gas Make-Up: in flow acoustic damping Others (specify):\_

| CODE NAME:     | LASER TECHNICAL AREA(S): Kinetics   |
|----------------|---|
| DEVICE COMPON  | ENTS TREATED: Laser Cavity  |
| PRINCIPAL PURP | OSE(S)/APPLICATION(S) OF CODE: General laser kinetics synthesis and               |
|                | oupled system of molecular kinetics, plasma kinetics, external discharge          |
|                | optical radiative extraction for a spatially homogeneous medium.                  |
|                | o a broad class of transient, electrically excited laser systems.                 |
|                | d, flexible input/output structure, well documented.                              |
| ASSESSMENT OF  |   |
| molecular ki   | netics reactions and species, a completely coupled laser kinetics                 |
|                | Molecular kinetics subroutines for an arbitrary reaction scheme                   |
|                | ed automatically into FORTRAN source code and coupled to plasma kinetics          |
|                |   |
| ASSESSMENT OF  | ds. etc.<br>LIMITATIONS: Applicable to transient analysis of electrically excited |
|                | . Developed in connection with rare gas halide excimer lasers                     |
| (e.g. KrF).    | Capability is quite comprehensive and general.                                    |
|                |   |
| OTHER UNIQUE F | EATURES: Program automatically synthesizes its own molecular kinetics             |
|                | for execution. Secondary electron collisions are automatically linked             |
|                | kinetics analysis provided by numerical solution of Boltzmann equation.           |
|                | alysis contains superelastic/electron-electron/inelastic/mom.transfer.            |
|                |   |
| ORIGINATOR/KEY |   |
|                | William B. Lacina   |
| Organization   | : Northrop Research & Technology Center   |
| Address:       | One Research Park, Palos Verdes Peninsula, CA 90274                               |
| Phone:(2       | 13) 377-4811 ext', 362  |
| AVAILABLE DOC  | JMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and   |
|                | Publication): "Theoretical Modelling of Molecular and Electron Kinetic            |
|                | ol. I: Theoretical Formulation of Analysis and Description of                     |
|                | grams. Vol. II: Fortran Computer Program Listings, "Northrop                      |
| Rept. #NRTC-   | 79-7R, January 1979. (T,U,L)  |
|                |   |
|                |   |
| STATUS:        |   |
|                | 100   |
|                | Currently?; yes   |
|                | ication?: no Modifications by other users may be in progress.                     |
| Purpose        | (s): Modifications by other users may be in progress.                             |
|                |   |
|                |   |
| Ownership?     | Northrop Research & Tech./William B. Lacina                                       |
| Proprietary    | Public Domain   |
| MACHINE/OPERA  | TING SYSTEM (on which installed): CDC 6600  |
|                |   |
| TRANSPORTABLE  | ; <sub>2</sub> . yes  |
|                | pendent Restrictions; Yes (CDC word size)   |
| Macinio Del    |   |
| SELF-CONTAINE  | 22. 100   |
|                | 1.00  |
| Other Codes    | Required (name, purpose):   |
|                |   |
| ESTIMATE OF RE | SOURCES REQUIRED FOR RUNS:  |
|                | Core Size (Octal Words)   Execution Time (sec, CDC 7600)                          |
| Small Job:     |   |
| Typical Job    | 200,000   |
| Large Job:     |   |
|                | Number of FORTRAN Lines: 6,000  |
| COMMENTS:      |   |
|                |   |
|                |   |

CODE NAME: LASER

| CODE STRUCTURE   | 3. LASING KINETICS MODEL                        |
|--|---|
| COORDINATE SYSTEM ( ):   | GENERAL (specify);                              |
| Cartesian: NA Expanding:   | Lasing Species: ONE                             |
| KINETICS GRID DIMENSIONALITY (1):  | Number of Species: arbitrary                    |
| 1-D: <u>Y</u> 2-D;   | Number of Reactions: arbitrary                  |
| 3-D:   | Other Major Species Considered:                 |
| GAIN REGION SYMMETRY RESTRICTIONS:   | Other Major Species Considered:                 |
| Gain Vary Along Optical Axis: no   |   |
|  |   |
| Flow Direction;  | IMPACT EXCITATION MODELED (♥):                  |
| NUMERICAL SCHEME USED IN RATE  | (Reference)                                     |
| CALCULATION (1):   | Vibrational:                                    |
| Explicit:  |   |
| Implicit:  | Others (specify):                               |
| Others (specify): rate constants from input  | t,  |
| and from Boltzmann plasma calculations.  | ENERGY TRANSFER MODES MODELED ( ):  (Reference) |
| REFERENCE OF METHOD USED:  | V-T:  |
| The Charles of the Ch | V-R:  |
|  | V - V:  |
| PLASMA KINETICS MODEL  | Others (specify):                               |
| NUMBER OF SPECIES TREATED (specify):   | Lasing Transition: P-Branch:                    |
| Number of Positive   | R-Branch;                                       |
| Species: arb.  | Single Line Model ( ):                          |
| Number of Negative   | Mult:-Line Model ( <b>√</b> ):                  |
| Species: arb.  | Assumed Rotational Population                   |
| Number of Neutral arb.   | Distribution State ( );                         |
| REACTION MECHANISM MODELED (√):  | Equilibrium:                                    |
| Primary Ionization: (Reference)  | Nonequilibrium: Number of Laser Lines           |
| E-Beam:  | Modeled:  |
| Self-Sustained: V  | Source of Rate Coefficients Used in Code        |
| UV-Initiated:  |   |
| Others (specify): reasonably arbitrary.  |   |
|  | LINE PROFILE MODELS (V):                        |
| Secondary Ionization (Reference)   | Doppler Broadening:                             |
| Attachment:  | Collisional Broadening:                         |
| Detachment:  | Others (specify);                               |
| Ion-Ion Recom-   |   |
| bination:  |   |
| Charge Transfer:   | 4. RECIRCULATION CONTAMINANTS                   |
| Dissociation/  | MODELED ( <b>√</b> ): none                      |
| Recombination:   | OX: OHX:  |
| Others (specify):  | NO <sub>x</sub> : HNO <sub>x</sub> :            |
|  | Others (specify):                               |
| Source of Rate Coefficients Used:  | REFERENCE FOR REACTION MECHANISM                |
| mi amallamanus   | AND RATES:                                      |
| miscellaneous  |   |
| DISCHARGE POWER INPUT MODELED (V):   |   |
| DISCHARGE POWER INPUT MODELED (1):  Uniform: Non-Uniform:  |   |
| DISCHARGE POWER INPUT MODELED (V):   | OTHER UNIQUE FEATURES;                          |

| CODE NAME: LAS   | SIM  | TECHNICAL AREA(S): Kinetics  |
|--|--|--|
|  | TS TREATED:  |  |
| PRINCIPAL PURPOSI  | E(S)/APPLICATION(S)  | OF CODE:   |
| Simulation of U  | JV initiated, sel  | f-sustained discharge - pumped XeF lasers.   |
|  |  |  |
|  |  |  |
|  |  |  |
| ASSESSMENT OF CA   | PABILITIES:  |  |
| Predicts discha  | arge & laser oper  | ation - physical description of experimenta  |
| system is used.  | . Circuit - disc   | harge interaction is modeled.  |
|  |  |  |
| ASSESSMENT OF LIM  | AITATIONS:   |  |
| Spatially unifo  | orm plasma/laser   | model.   |
|  |  |  |
|  |  |  |
| OTHER UNIQUE FEA   | TURES:   |  |
|  |  |  |
|  |  |  |
|  |  |  |
| ORIGINATOR/KEY CO  | ONTACT:  |  |
| Name: L.E.   |  |  |
|  | Westinghouse R&D   | )  |
|  | 10 Beulah Road, P  |  |
|  | 256-7552   |  |
| Phone: 414-  |  |  |
|  |  | cify, use T = Theory, II = User's Manual I Listing, and  |
| AVAILABLE DOCUMI<br>RP = Related Po  | ENTATION (Please speublication):   | ecify, use T = Theory, U = User's Manual, L = Listing, and   |
| AVAILABLE DOCUMI<br>RP = Related Po<br>RP: "Formation  | ENTATION (Please speublication): n, Quenching & Ab   | sorbition Processes in Self-Sustained  |
| AVAILABLE DOCUMI<br>RP = Related Po<br>RP: "Formation<br>Discharge   | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase   | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI<br>RP = Related Po<br>RP: "Formation<br>Discharge   | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase   | sorbition Processes in Self-Sustained  |
| AVAILABLE DOCUMI<br>RP = Related Po<br>RP: "Formation<br>Discharge   | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase   | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI<br>RP = Related Po<br>RP: "Formation<br>Discharge   | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase   | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI<br>RP = Related Po<br>RP: "Formation<br>Discharge   | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase   | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.   | ENTATION (Please speublication):  n, Quenching & Abe e Pumped XeF Lase Mitchell. Proc.   | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur  | ENTATION (Please spendification):  n, Quenching & Abe e Pumped XeF Lase Mitchell. Proc.  | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modificat  | ENTATION (Please spendification):  n, Quenching & Abe e Pumped XeF Lase Mitchell. Proc.  | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modificat  | ENTATION (Please spendification):  n, Quenching & Abe e Pumped XeF Lase Mitchell. Proc.  | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modificat  | ENTATION (Please spendification):  n, Quenching & Abe e Pumped XeF Lase Mitchell. Proc.  | sorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,   |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modificat Purpose(s):  | ENTATION (Please speublication): n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  | esorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,<br>Int'l Conf.on Lasers 1978, Orlando, FL (RP  |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?:  | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?:  Gov't contract   | esorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,<br>Int'l Conf.on Lasers 1978, Orlando, FL (RP  |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modificat Purpose(s): Ownership?: Proprietary?:  | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?: : Gov't contract  | esorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,<br>Int'l Conf.on Lasers 1978, Orlando, FL (RP  |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modificat Purpose(s): Ownership?: Proprietary?:  | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?:  Gov't contract   | esorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,<br>Int'l Conf.on Lasers 1978, Orlando, FL (RP  |
| AVAILABLE DOCUMI RP = Related Port   | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?: :  Gov't contract No NG SYSTEM (on which in the contract)   | esorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,<br>Int'l Conf.on Lasers 1978, Orlando, FL (RP  |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIO  TRANSPORTABLE?:  | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  Prently?: Yes  tion?:  Gov't contract  NO  NG SYSTEM (on which in Yes  | esorbition Processes in Self-Sustained  er" L.E. Kline, L.J. Denes, S. G. Leslie,  Int'l Conf.on Lasers 1978, Orlando, FL (RP  |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIO  TRANSPORTABLE?:  | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  Prently?: Yes  tion?:  Gov't contract  NO  NG SYSTEM (on which in Yes  | esorbition Processes in Self-Sustained<br>er" L.E. Kline, L.J. Denes, S. G. Leslie,<br>Int'l Conf.on Lasers 1978, Orlando, FL (RP  |
| AVAILABLE DOCUMI RP = Related Port RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modificat Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIO  TRANSPORTABLE?: Machine Depend   | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  Prently?: Yes  tion?:  Gov't contract  No  NG SYSTEM (on which in Yes  dent Restrictions:  | esorbition Processes in Self-Sustained  er" L.E. Kline, L.J. Denes, S. G. Leslie,  Int'l Conf.on Lasers 1978, Orlando, FL (RP  |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIO  TRANSPORTABLE?: Machine Dependence   | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  Prently?: Yes  tion?:  :  Gov't contract  NO  NG SYSTEM (on which in Yes  dent Restrictions:   | esorbition Processes in Self-Sustained er" L.E. Kline, L.J. Denes, S. G. Leslie,  Int'l Conf.on Lasers 1978, Orlando, FL (RP)  installed): UNIVAC-1100   |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIO  TRANSPORTABLE?: Machine Depend  SELF-CONTAINED?: Other Codes Re  | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  Prently?: Yes  tion?:  :  Gov't contract  No  NG SYSTEM (on which in Yes  dent Restrictions:   | psorbition Processes in Self-Sustained r" L.E. Kline, L.J. Denes, S. G. Leslie, Int'l Conf.on Lasers 1978, Orlando, FL (RP  installed): UNIVAC-1100  Boltzman Solver is required to calculate  |
| AVAILABLE DOCUMI RP = Related Portion RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modificat Purpose(s):  Ownership?: Proprietary?: MACHINE/OPERATIN  TRANSPORTABLE?: Machine Depend  SELF-CONTAINED?: Other Codes Re electron   | ENTATION (Please spendication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  Prently?: Yes tion?:  :  Gov't contract No NG SYSTEM (on which in Yes dent Restrictions:  equired (name, purpose a excitation rates)  | psorbition Processes in Self-Sustained er" L.E. Kline, L.J. Denes, S. G. Leslie, Int'l Conf.on Lasers 1978, Orlando, FL (RP  installed): UNIVAC-1100  Boltzman Solver is required to calculate vs. E/P   |
| AVAILABLE DOCUMI RP = Related Portion RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIN  TRANSPORTABLE?: Machine Dependence SELF-CONTAINED?: Other Codes Re electron ESTIMATE OF RESO                            | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?: :  Gov't contract No NG SYSTEM (on which in Yes dent Restrictions:  equired (name, purpose in excitation rates) furces required Fo                        | psorbition Processes in Self-Sustained or L.E. Kline, L.J. Denes, S. G. Leslie, Int'l Conf.on Lasers 1978, Orlando, FL (RP  installed): UNIVAC-1100  D. Boltzman Solver is required to calculate vs. E/P  R RUNS:  |
| AVAILABLE DOCUMI RP = Related Portion RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIN  TRANSPORTABLE?: Machine Depend  SELF-CONTAINED?: Other Codes Re electron ESTIMATE OF RESO                               | ENTATION (Please spendication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  Prently?: Yes tion?:  :  Gov't contract No NG SYSTEM (on which in Yes dent Restrictions:  equired (name, purpose a excitation rates)  | psorbition Processes in Self-Sustained or L.E. Kline, L.J. Denes, S. G. Leslie, Int'l Conf.on Lasers 1978, Orlando, FL (RP installed): UNIVAC-1100  Diagram Solver is required to calculate vs. E/P  R RUNS:   |
| AVAILABLE DOCUMI RP = Related Portion RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIN  TRANSPORTABLE?: Machine Depend  SELF-CONTAINED?: Other Codes Re electron ESTIMATE OF RESO                               | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?: :  Gov't contract No NG SYSTEM (on which in Yes dent Restrictions:  equired (name, purpose in excitation rates) furces required Fo                        | psorbition Processes in Self-Sustained or L.E. Kline, L.J. Denes, S. G. Leslie, Int'l Conf.on Lasers 1978, Orlando, FL (RP  installed): UNIVAC-1100  D. Boltzman Solver is required to calculate vs. E/P  R RUNS:  |
| AVAILABLE DOCUMI RP = Related Portion RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIN  TRANSPORTABLE?: Machine Depend  SELF-CONTAINED?: Other Codes Re electron ESTIMATE OF RESO                               | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?: :  Gov't contract No NG SYSTEM (on which in Yes dent Restrictions:  equired (name, purpose in excitation rates) furces required Fo                        | psorbition Processes in Self-Sustained or L.E. Kline, L.J. Denes, S. G. Leslie, Int'l Conf.on Lasers 1978, Orlando, FL (RP installed): UNIVAC-1100  Diagram Solver is required to calculate vs. E/P R RUNS:  |
| AVAILABLE DOCUMI RP = Related Portion RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIN  TRANSPORTABLE?: Machine Dependence SELF-CONTAINED?: Other Codes Ree electron ESTIMATE OF RESO                           | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?: :  Gov't contract No NG SYSTEM (on which in Yes dent Restrictions:  equired (name, purpose in excitation rates) URCES REQUIRED FO Core Size (Octal Words) | psorbition Processes in Self-Sustained or" L.E. Kline, L.J. Denes, S. G. Leslie, Int'l Conf.on Lasers 1978, Orlando, FL (RP installed): UNIVAC-1100  Description Processes in Self-Sustained Or Leslie, Int'l Conf.on Lasers 1978, Orlando, FL (RP Int'l Conf.on Lasers 1978, Orlando, FL ( |
| AVAILABLE DOCUMI RP = Related Po RP: "Formation Discharge and R.R.  STATUS: Operational Cur Under Modifical Purpose(s): Ownership?: Proprietary?: MACHINE/OPERATIN  TRANSPORTABLE?: Machine Depend  SELF-CONTAINED?: Other Codes Re electron ESTIMATE OF RESO Small Job: Typical Job: Large Job: | ENTATION (Please speublication):  n, Quenching & Abe Pumped XeF Lase Mitchell. Proc.  rrently?: Yes tion?: :  Gov't contract No NG SYSTEM (on which in Yes dent Restrictions:  equired (name, purpose in excitation rates) URCES REQUIRED FO Core Size (Octal Words) | installed): UNIVAC-1100  Boltzman Solver is required to calculate vs. E/P  R RUNS:  Execution Time (sec., CDC ?600)  LEXECUTE SOLVER SO |

|                                      | CODE NAME: LASIM                                      |
|--------------------------------------|---|
| I, CODE STRUCTURE                    | 3. LASING KINETICS MODEL                              |
| COORDINATE SYSTEM (V):               | GENERAL (specify):                                    |
| Cartesian: V Expanding:              | Lasing Species: 1                                     |
| KINETICS GRID DIMENSIONALITY (√):    | Number of Species: 9                                  |
| 1-D:                                 | Number of Reactions: 20                               |
| 3-D: 0-D X                           | Other Major Species Considered:                       |
| GAIN REGION SYMMETRY RESTRICTIONS:   |   |
| Gain Vary Along Optical Axis: No     |   |
| Flow Direction: No                   | IMPACT EXCITATION MODELED ( ):                        |
| KINETICS MODELED: Pulsed: V CW:      | (Reference)   |
| NUMERICAL SCHEME USED IN RATE        | Vibrational:  |
| CALCULATION ():                      | Electronic:   |
| Explicit:                            | Others (specify):                                     |
| Implicit:                            |   |
| Ciners (specify):                    | ENERGY TRANSFER MODES MODELED ( ):                    |
|                                      | V-T:  |
| REFERENCE OF METHOD USED:            | V-R:  |
|                                      | V - V:  |
|                                      | Others (specify):                                     |
| 2. PLASMA EINETICS MODEL             | Lasing Transition: P-Branch:                          |
| NUMBER OF SPECIES TREATED (specify); | R-Branch:   |
| Number of Positive                   | Single Line Model (1):                                |
| Species: 2 Number of Negative 2      | MuIti-Line Model (√I:                                 |
| Species: 2  Number of Neutral        | Assumed Rotational Population Distribution State ( !: |
| Species: 5                           | Equilibrium:  |
| REACTION MECHANISM MODELED (√):      | Nonequilibrium;                                       |
| Prin; ary Ionization; (Reference)    | Number of Laser Lines                                 |
| E-Beani:                             | Modeled:  |
| Self-Sustained: 🗸                    | Source of Rate Coefficients Used in Code;             |
| UV-Initiated: 🗸                      |   |
| Others (specify):                    |   |
|                                      | LINE PROFILE MODELS ( ):                              |
| Secondary ionization (Reference)     | Doppler Broadening:                                   |
| Attachment:                          | Collisional Broadening:                               |
| Detachment:                          | Others (specify):                                     |
| Ion-Ion Recom-                       |   |
| Charge Transfer:                     | 4. RECIRCULATION CONTAMINANTS                         |
| Discount on /                        | MODELED ( <b>√</b> ): None                            |
| Recombination:                       | O <sub>X</sub> : OH <sub>X</sub> :                    |
| Cthers (specify):                    | NO <sub>x</sub> : IHNO <sub>x</sub> :                 |
|                                      | Others (specify):                                     |
| Source of Rate Coefficients Used:    | REFERENCE FOR REACTION MECHANISM                      |
| DISCHARGE POWER INPUT MODELED (V):   | AND RATES: Kline et al., Proc Laser '78               |
| Uniform; V Non-Uniform;              | OTHER INIOUS SEATURES                                 |
| E-Field:                             | OTHER UNIQUE FEATURES:                                |
| Others (specify):                    |   |
|                                      |   |
|                                      |   |

| CODE NAME:              | MOC                    | TECHNICAL AREA(S): Gas Dynamics   |
|-------------------------|------------------------|---|
| DEVICE COMPO            | NENTS TREATED:         | Cavity  |
| PRINCIPAL PUI           | POSE(S)/APPLICATIO     | N(S) OF CODE: Computes the transient flow associated  |
| with sudde              | en energy deposit      | ion that is characteristic of pulsed laser operation  |
|                         |                        |   |
|                         |                        |   |
|                         |                        |   |
| ASSESSMENT O            | F CAPABILITIES:        |   |
|                         |                        |   |
|                         |                        |   |
|                         |                        | angle corresponding with colid boundaries   |
| not modele              |                        | nock wave interaction with solid boundaries   |
|                         |                        |   |
|                         |                        |   |
| OTHER UNIOUE            | FEATURES:              |   |
| O,Z OZOZ                |                        |   |
|                         |                        |   |
|                         |                        |   |
| ORIGINATOR/K            | EY CONTACT:            |   |
|                         | C. C. Shih and G.      |   |
| Organizati              | on: Mech. Eng.         | Dept., Univ. of Ala. in Huntsville  |
| Address:_               | Huntsville, AL         | 35809   |
| Phone:                  | (205) 895-6330, (      | 205) 895-6075   |
|                         |                        | e specify, use T = Theory, U = User's Manual, L = Listing, and                                      |
|                         |                        | C. Shih, G. R. Karr, J. F. Perkins, Investigation ing Problems Characteristics of High Energy Laser |
|                         |                        | Ali Research Report No. 219, March 1979.  |
|                         |                        |   |
|                         |                        |   |
|                         |                        |   |
| CTATUE.                 |                        |   |
| STATUS:                 | A Currently 2. X       |   |
| Uperations<br>Under Mos | al Currently?: X       |   |
| Onder Mod               | Intend to              | look at wave interaction with acoustic attenuators  |
| rui po                  | 36.31.                 |   |
|                         |                        |   |
| Ownership               | ,2. UAH                |   |
|                         | ry?:                   |   |
| •                       |                        | hich installed): UNIVAC 1108  |
|                         |                        |   |
| TRANSPORTAB             | LE?: yes               |   |
| Machine D               | ependent Restrictions; | none  |
|                         |                        |   |
| SELF-CONTAIN            | ED?: yes               |   |
| Other Cod               | es Required (name, pu  | pose):  |
|                         |                        |   |
| ESTIMATE OF             | RESOURCES REQUIRE      | FOR RUNS:   |
|                         | Core Size (Octal V     | fords) Execution Time (sec, CDC 7600)   |
| Small Job               |                        |   |
| Typical Jo              | b;                     | order of 100 sec.   |
| Large Job               | :                      |   |
| Approxim                | ate Number of FORTRA   | N Lines:  |
| COMMENTS: _             |                        |   |
|                         |                        |   |
|                         |                        |   |

CODE NAME: MOC

DECONTAMINATION METHOD TREATED (√): I. CODE STRUCTURE COORDINATE SYSTEM ( ): Scrubber: Cartesian: V Expanding: FLUID GRID DIMENSIONALITY ( ): Catalytic Reactor: 1-D: \_\_\_\_\_ Others (specify): \_\_\_ 2-D: \_\_\_\_ 3-D: \_\_ Time Dependent: FLOW FIELD MODELED (√): 4. ACOUSTIC ATTENUATION MODEL Compressible Flow: GENERAL FEATURES MODELED (√): Incompressible: Single Pulse: \_\_\_ Repetitive Pulse: \_\_\_ DIMENSIONALITY TREATED ( ): Viscous Flow: No Flow: Time-Dependent: BASIC MODELING APPROACH (√): Algebraic: V Integral Method: DISTURBANCE MODELED ( ): Finite Difference: Pressure Wave: V Entropy Wave: V Others (specify): \_\_\_ Others (specify): WAVE PROPAGATION TREATMENT ( $\sqrt{}$ ): REFERENCE FOR APPROACH USED:\_ Method of Characteristics Linear Wave: \_\_\_\_\_ Nonlinear Wave: V Others (specify): 2. GAS DYNAMICS MODEL FEATURES: THEORETICAL BASIS: (Reference)
Method of Characteristics GAS SUPPLY MODELED (V): Mixture Preparation: Mixture Injection: Nozzles: NUMERICAL METHODOLOGY: (Reference) Flow Plates: Finite Difference Others (specify): ACOUSTIC ATTENUATORS CONSIDERED ( ): CAVITY INITIAL CONDITION DETERMINED BY (specify); given Muffler: Heat Exchanger: Horn: Porous Wall: Others (specify): none 3. EXHAUST RECIRCULATION MODEL GENERAL SYSTEM MODELED (√): 5. MODEL EFFECTS ON OPTICAL MODES DUE Open System: V Closed System: Closed Cycle: \_\_\_ Index of Refraction Variation?: EXHAUST SYSTEM FEATURES (√): Other (specify): Fractional density Pressure Recovery: gradient (Af/f) Ejector System: Compressor Fan: Heat Exchanger: OTHER UNIQUE FEATURES: Gas Make-Up: Others (specify):

| NRL Laser Kinetics  CODE NAME: Code (Unofficial) TECHNICAL AREA(S): Kineti   | CS                               |
|--|----------------------------------|
| DEVICE COMPONENTS TREATED: Laser Cavity; Chemical Kinetic  |                                  |
|  |                                  |
| PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE:  Modeling of a variety of high power gas lasers. Mostly:                                      | /electron kinetics               |
| Some non-lasing applications such as modeling of absorpt   |                                  |
| gases and isotope separation kinetics.   | -                                |
|  |                                  |
| ASSESSMENT OF CAPABILITIES: Highly flexible; Has been easily   | v adapted to a wide              |
| variety of physical systems. Easily portable from one of   |                                  |
| No convergence problems with chemical kinetics integrator  | r. Coupled external              |
| circuit.   |                                  |
| ASSESSMENT OF LIMITATIONS: Spatially homogeneous (zero-dime  | nsional) approximation           |
| for kinetics. E-beam ionization rate provided as extern  | al waveform.                     |
| Secondary electron kinetics (time-dependent).  |                                  |
|  |                                  |
| OTHER UNIQUE FEATURES: Reaction scheme specified using sym reactants and products. Output provides detailed and us of kinetics and lasing. | bolic names for eful description |
|  |                                  |
| ORIGINATOR/KEY CONTACT:  |                                  |
| Name: Louis J. Palumbo   |                                  |
| Organization, Laser Physics Branch, Code 6540  |                                  |
| Naval Research Laboratory, Washington, DC 2  | 0375                             |
| Phone: (202) 767-2255  |                                  |
| AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's MaRP = Related Publication):   | anual, L = Listing, and          |
| (T, RP): T. H. Johnson, L.J. Palumbo and A.M. Hunter, I  | I, "Kinetics Simulation          |
| of High-Power Gas Lasers", IEEE J. Quant. Elec   | tron., Vol. QE-15,               |
| No. 5, pp. 289-301, (May 1979).  |                                  |
| (L): Originator supplies listings and tape copies on re  | quest. (Listing is               |
| well commented) (SEE ATTACHED SHEET)   |                                  |
| STATUS:  |                                  |
| Operational Currently?: Yes (several versions)   |                                  |
| Under Modification?:yes  |                                  |
| Purposets): Modifications are underway to make code i  | more user oriented               |
| and to make more efficient use of computer memory  | •                                |
|  |                                  |
| Ownership?: No (developed on U.S. Gov't time-available   |                                  |
| Proprietary?: No (earlier versions have been sent to pri   |                                  |
| MACHINE/OPERATING SYSTEM (on which installed): Texas Instrument Computer (ASC). Also was successfully adapted to IBM-37                    | s - Advanced Scientific O.       |
| TRANSPORTABLE?: Resonably  |                                  |
| Machine Dependent Restrictions: Some versions contain ENCODE   | /DECODE statements,              |
|  | ent on a vectorizing             |
| SELF-CONTAINED?: Yes / Fortran compiler.   |                                  |
| Other Codes Required (name, purpose): None   |                                  |
| ESTIMATE OF RESOURCES REQUIRED FOR RUNS:   |                                  |
|  | 001                              |
| Small Job: Core Size (Octal Words)   Execution Time (sec, CDC 76   |                                  |
| Typical Job: 150,000 " " 120   |                                  |
| Large Job: 1250,000 " " " 600  |                                  |
| Approximate Number of FORTRAN Lines: 6000  |                                  |
| COMMENTS: Very simple time-dependent lasing computation for  | or a Fabry-Perot                 |
| cavity using constant gain, geometric optics.  |                                  |

# AVAILABLE DOCUMENTATION con't: CODE NAME: NRL Laser Kinetics Code

- (U, L): Being written will be published as an NRL Memorandum Report by L. J. Palumbo (early 1981) (perhaps a series of memo reports).
- (RP): Several papers involving interpretation of experimental results using a model published mostly in Appl. Phys. Lett. 1977-1980.

CODE NAME: NRL LASER 1. CODE STRUCTURE 3. LASING KINETICS MODEL COORDINATE SYSTEM ( ): GENERAL (specify): Cartesian: Expanding: Lasing Species: KINETICS GRID DIMENSIONALITY (1): Number of Species: 10-50 typical 1-D: V 6 2-D: Number of Reactions: 10-200 typical 3-D: \_\_\_\_ (Spatially homogeneous (Zero-D) Other Major Species Considered: \_ GAIN REGION SYMMETRY RESTRICTIONS: Gain Vary Along Optical Axis: \_\_\_\_ (sometimes) Flow Direction: no flow IMPACT EXCITATION MODELED ( ): KINETICS MODELED: Pulsed: \_ CW: \_ CW: \_ V (Reference) NUMERICAL SCHEME USED IN RATE Vibrational. CALCULATION (1):

Explicit: Electronic: Others (specify): Implicit: Others (specify): Runge-Kutta-Treanor ENERGY TRANSFER MODES MODELED ( ): Method for stiff diff. eq.s (Reference) V-T: V.1 V-R: unusually small for C.E. Treanor REFERENCE OF METHOD USED: Math. Compat. Vol. 20, p 39 (1966) Tthe systems modeled Others (specify): 2. PLASMA KINETICS MODEL Lasing Transition: P-Branch: NUMBER OF SPECIES TREATED (specify): R-Branch: Number of Positive 0-15 typical Single Line Model (V): Species: Multi-Line Model (√): \_ Number of Negative 0-5 typical Species: Assumed Rotational Population Distribution State (√): Number of Neutral Species: 5-50 typical Equilibrium: REACTION MECHANISM MODELED ( 1: Nonequilibrium: Primary Ionization: Number of Laser Winas Modeled: | external waveform for E-Beam: Source of Rate Coefficients Used in Code: Self-Sustained: 🗸 /ionization rate mostly open literature UV-Initiated: Others (specify): E-beam sustained as well LINE PROFILE MODELS ( ): as pure e-beam pumpted. Doppler Broadening: \_\_none Secondary Ionization (Reference) Collisional Broadening: Attachment: Others (specify): Detachment: ton-ton Recombination: 4. RECIRCULATION CONTAMINANTS Charge Transfer: MODELED (): none Dissociation/ \_\_ OH<sub>x</sub>: \_\_ Recombination: NO : HNO : Others (specify): Others (specify): Source of Rate Coefficients Used: mostly open literature REFERENCE FOR REACTION MECHANISM AND RATES: DISCHARGE POWER INPUT MODELED ( ): Uniform: V Non-Uniform: OTHER UNIQUE FEATURES: E-Field: V Others (specify): external circuit coupled to kinetics. Electron kinetics are modeled either by solving the steady state Boltzmann transport equation or by a time-dependent but greatly simplified rate-equation method,

| or the 10 um P(14  |
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CODE NAME: OPTEX CO<sub>2</sub>, N<sub>2</sub>, He) dered: ED (**√**): Sov. J. Quantum Electron.4, 843 MODELED (√): uant. Electron. (1973) ant. Electron. inch: V nch; V pulation s Used in Code: , 26 (1969) ANTS MECHANISM

| CODE CENTICETURE                               | A LAGNIC WINETIGG  |
|--|--|
| . CODE STRUCTURE                               | 3. LASING KINETICS MODEL                                   |
| COORDINATE SYSTEM (√):                         | GENERAL (specify);   |
| Cartesian: Expanding: V                        | 3 (6   |
| KINETICS GRID DIMENSIONALITY (√):              | Number of Species: 3 (C                                    |
| 1-D: 2-D:                                      | Number of Reactions:                                       |
| 3-D:   | Other Major Species Consi                                  |
| GAIN REGION SYMMETRY RESTRICTIONS:             |  |
| Gain Vary Along Optical Axis:                  |  |
| Flow Direction:                                | IMPACT EXCITATION MODEL                                    |
| KINETICS MODELED: Pulsed: V CW:                | (Refe  |
| NUMERICAL SCHEME USED IN RATE CALCULATION (1): | Vibrational:   |
| Explicit:                                      | Electronic:  |
| Implicit:                                      | Others (specify):  |
| Others (specify):                              |  |
|  | ENERGY TRANSFER MODES N                                    |
|  | IEEE J. O  |
| REFERENCE OF METHOD USED:IEEE J.               | V-T: V OE-9, 139   |
| Quant. Electron. QE-9, 139 (1973)              | V-R:   |
|  | V-V: OE-9, 139   |
| . PLASMA EINETICS MODEL                        | Others (specify):  |
| NUMBER OF SPECIES TREATED (specify):           | Lasing Transition: P-Bra                                   |
| Number of Positive                             | R-Bra  |
| Species:                                       | Single Line Model (♥):                                     |
| Number of Negative                             | Multi-Line Model (√):                                      |
| Species: 3                                     | Assumed Rotational Popularibution State $(\sqrt{\cdot})$ : |
| Species:                                       | Equilibrium:   |
| REACTION MECHANISM MODELED (√):                | Nonequilibrium;  |
| Primary Ionization; (Reference)                | Number of Lager Lines                                      |
| E-Beam;  | Modeled:   |
| Self-Sustained:                                | Source of Rate Coefficient. Rev. Mod. Phys. 41             |
| UV-Initiated:                                  | Nevi nodi inju   |
| Others (specify):                              | I DE PROFILE MOREIGA I                                     |
|  | LINE PROFILE MODELS ( ):                                   |
| Secondary Ionization (Reference)               | Doppler Broadening:  |
| Attachment:                                    | Collisional Broadening:                                    |
| Detachment:                                    | Others (specify):  |
| Ion-Ion Recom-<br>bination;                    |  |
| Charge Transfer,                               | 4. RECIRCULATION CONTAMINA                                 |
| Dissociation/                                  | MODELED ( <b>√</b> ); None                                 |
| Recombination:                                 | O <sub>x</sub> : OH <sub>x</sub> :                         |
| Others (specify):                              | NO <sub>x</sub> : HNO <sub>x</sub> : Others (specify):     |
|  | Omers (specify):   |
| Source of Rate Coefficients Used;              | REFERENCE FOR REACTION                                     |
|  | AND RATES:   |
| DISCHARGE POWER INPUT MODELED (V):             |  |
| Uniform: Non-Uniform:                          | OTHER UNIQUE FEATURES:                                     |
| E-Field:                                       |  |
| Others (specify):                              |  |
|  |  |

| CODE NAME: POSEIDON* TECHNICAL AREA(S): Gas Dynamics  DEVICE COMPONENTS TREATED: Laser Cavity; Acoustic Attenuation Subsystem  PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The code is used to model one-dimensional  |
|--|
| PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The code is used to model one-dimensional   |
|  |
| flow and acoustics in the laser cavity and the acoustic attenuation subsystem. This  |
| is used to predict recovery time of the medium within the laser cavity to a  |
| specified homegeneity. A two-dimensional version also exists.  |
|  |
| ASSESSMENT OF CAPABILITIES: The code has demonstrated stable and accurate numerical  |
| solutions to unsteady flow problems characterized by both strong shock waves and weak acoustic level waves with extremely small numerical diffusion (no artifical  |
| viscosity is required).  |
|  |
| ASSESSMENT OF LIMITATIONS: Boundary layer phenomena are not simulated and two-dimensional version has high noise floor.  |
| dimensional version has high horse froot.  |
|  |
| OTHER UNIQUE FEATURES: Any type of gas at any temperature may be employed. Any   |
| number of repetitive pulses may be specified. System geometry may be altered   |
| at will. The code incoporates: compressibility, nonlinearity, heat transfer,   |
| bulk resistance, and mass transport through the side walls. Reflections off of ORIGINATOR/KEY CONTACT: /a sudden expansion downstream of the laser cavity incorporate  |
| ORIGINATOR/KEY CONTACT: /a sudden expansion downstream of the laser cavity incorporate /two-dimensional gas dynamics to account for the shape of the   |
| Name: James H. Morris /openir  |
| Organization: Poseidon Research  |
| Address: 9550 Owensmouth Avenue, Chatsworth, CA 91311  |
| Phone: (213) 341-9172  |
| AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T = Poseidon Research Reports: #8, #16, #21, #22, #32  |
| RP = Boris, J.P. and Book, D. L. 1971 Flux Corrected Transport.  |
| I. Shasta, A Fluid Transport Algorithm That Works.   |
| Journal of Computational Physics 11, pp. 38-69 (1973)  |
|  |
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|  |
| STATUS:  |
| Operational Currently?: Yes  |
| Operational Currently?: Yes Under Modification?: NO  |
| Operational Currently?: Yes  |
| Operational Currently?: Yes Under Modification?: NO  |
| Operational Currently?: Yes Under Modification?: NO  |
| Operational Currently?; Yes Under Modification?: NO Purpose(s):  |
| Operational Currently?: Yes Under Modification?: NO  Purpose(s):  Ownership?: Poseidon Research Proprietary?: NO   |
| Operational Currently?: Yes Under Modification?: NO  Purpose(s):  Ownership?: Poseidon Research Proprietary?: NO  MACHINE/OPERATING SYSTEM (on which installed): CRAY I  |
| Operational Currently?:  |
| Operational Currently?; Yes  Under Modification?; NO  Purpose(s):  Ownership?; Poseidon Research  Proprietary?; NO  MACHINE/OPERATING SYSTEM (on which installed); CRAY I  |
| Operational Currently?; Yes Under Modification?: NO  Purpose(s):  Ownership?: Poseidon Research Proprietary?; NO  MACHINE/OPERATING SYSTEM (on which installed); CRAY I  TRANSPORTABLE?: Yes Machine Dependent Restrictions; None  |
| Operational Currently?; Yes  Under Modification?: NO  Purpose(s):  Ownership?: Poseidon Research  Proprietary?; NO  MACHINE/OPERATING SYSTEM (on which installed); CRAY I  TRANSPORTABLE?: Yes  Machine Dependent Restrictions; None   |
| Operational Currently?; Yes Under Modification?: NO  Purpose(s):  Ownership?: Poseidon Research Proprietary?; NO  MACHINE/OPERATING SYSTEM (on which installed); CRAY I  TRANSPORTABLE?: Yes Machine Dependent Restrictions; None  |
| Operational Currently?:  |
| Operational Currently?; Yes  Under Modification?: NO  Purpose(s):  Ownership?: Poseidon Research  Proprietary?; NO  MACHINE/OPERATING SYSTEM (on which installed); CRAY I  TRANSPORTABLE?: Yes  Machine Dependent Restrictions; None   |
| Operational Currently?:  |
| Operational Currently?: Yes Under Modification?: NO  Purpose(s):  Ownership?: Poseidon Research Proprietary?: NO  MACHINE/OPERATING SYSTEM (on which installed): CRAY I  TRANSPORTABLE?: Yes Machine Dependent Restrictions: None  SELF-CONTAINED?: Yes Other Codes Required (name, purpose):  ESTIMATE OF RESOURCES REQUIRED FOR RUNS: Core Size (Octal Words) Execution Time (sec, CDC 7600) |
| Operational Currently?:  |
| Operational Currently?;  |
| Operational Currently?:  |

POSEIDON

|   | CODE NAME: POSEIDON  |
|---|--|
| . CODE STRUCTURE  | DECONTAMINATION METHOD TREATED ( $$ ):   |
| COORDINATE SYSTEM (♥):  | Scrubber:  |
| Cartesian: Expanding:   | Shower:  |
| FLUID GRID DIMENSIONALITY (1):  | Catalytic Reactor:   |
|   | Others (specify): None   |
| 1-D:  | Others (specify):  |
| 3-D:  |  |
| Time Dependent:   |  |
|   | 4. ACOUSTIC ATTENUATION MODEL  |
| FLOW FIELD MODELED (1):  Compressible Flow:                                       | GENERAL FEATURES MODELED (√):  |
| Incompressible:   | Single Pulse:   Repetitive Pulse:  |
| Viscous Flow:   | DIMENSIONALITY TREATED (1):  |
| No Flow:  | 1-D: \( 2-D: \sqrt{3-D: \qquad 3-D: \qqquad 3-D: \qqquad 3-D: \qqquad 3-D: \qqquad 3-D: \qquad 3-D: \qqquad 3-D: \qqquad 3-D: \qqqua |
| BASIC MODELING APPROACH (√):  |  |
|   | Time-Dependent:  |
| Algebraic: Integral Method:   | DISTURBANCE MODELED (√):   |
| Finite Difference;  | Pressure Wave: V Entropy Wave: V   |
| Others (specify):   | Others (specify):  |
| REFERENCE FOR APPROACH USED:  | WAVE PROPAGATION TREATMENT (√):  |
| SHASTA Algorithm  |  |
| Boris & Book, J. Comp. Physiccs II, 38-69   | Linear Wave:   |
|   | Others (specify):  |
| . GAS DYNAMICS MODEL FEATURES:  |  |
| GAS SUPPLY MODELED (V):   | THEORETICAL BASIS: (Reference)   |
| ·   | Poseidon Research Report No. 16  |
| Mixture Preparation: Mixture Injection:   | Todeladii Nebediani Nepola iio.  |
|   | NUMERICAL METHODOLOGY: (Reference)   |
| Nozzies; Flow Plates;   | NOMERICAL METHODOLOGI: (Reference)   |
| Others (specify):   |  |
| Olivia (apectivi)   | ACOUSTIC ATTENUATORS CONSIDERED ( ):   |
| CAVITY INITIAL CONDITION DETERMINED   | Muffler: V Heat Exchanger: V   |
| CAVITY INITIAL CONDITION DETERMINED BY (specify): \$.5. Isentropic flow relations | Horn: V Porous Wall:   |
| and initial over-temperature distribution   |  |
|   | Others (specify):  |
| 3. EXHAUST/RECIRCULATION MODEL  |  |
| GENERAL SYSTEM MODELED (♥):   | 5. MODEL EFFECTS ON OPTICAL MODES DUF  |
| Open System: V Closed System:   | TO (1):  |
| Closed Cycle:   | Index of Refraction Variation?:  |
| EXHAUST SYSTEM FEATURES ( );  | Other (specify):   |
| Pressure Recovery:  |  |
| Ejector System;   |  |
| Compressor/Fan:   |  |
| Heat Exchanger;   | OTHER UNIQUE FEATURES:   |
| Gas Make-Up.  |  |
| Others (specify):   |  |
| 1D: Sudden expansion boundary condition   |  |
| 2D: Open  |  |
|   |  |
|   |  |
|   |  |

| CODE NAME: PSI LASER * TECHNICAL AREA(S): Kinetics  |          |
|---|----------|
| DEVICE COMPONENTS TREATED:Laser Cavity  |          |
| PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: A series of codes for general  | <u>1</u> |
| kinetic calculations, D <sub>2</sub> /HCl, Kr <sub>2</sub> . Xe <sub>2</sub> , Xe <sub>2</sub> , KrF, CO etc.           |          |
| Calculate cavity gain and powerout for a Fabry-Perot Resonator  |          |
|   | -        |
|   | -        |
| ASSESSMENT OF CAPABILITIES: One-dimensional in time, and one-dimensional  | 1        |
| in space.   | -        |
|   | -        |
| ASSESSMENT OF LIMITATIONS:  | _        |
|   | -        |
|   | -        |
| OTHER UNIQUE FEATURES: Fluid Dynamics can be modeled separately. Has been   | -        |
| used for GDL and Chemical lasers. Output can be used for amplification  | -        |
| calculations.   | -        |
|   | -        |
| ORIGINATOR/KEY CONTACT:   | -        |
| Name: Paul Lewis or Ray L. Taylor   |          |
| Organization: Physical Sciences, Inc. Research and Laser Techno   | logy, In |
| Address: 30 Commerce Way, Woburn, MA 01801 6 Frank St., Rockport, MA  | 01966    |
| Phone: (617) 933-8500 (617) 546-7798  | _        |
| AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): |          |
| RP: PSI TR 19   | _        |
| PSI TR 182  | _        |
|   | _        |
|   | _        |
|   | _        |
| STATUS:   |          |
| Operational Currently?: X   |          |
| Under Modification?:  |          |
| Purpose(s):   |          |
|   |          |
| Ownership?: PSI, RLT  |          |
| Proprietary':   | -        |
| MACHINE/OPERATING SYSTEM (on which installed): Prime 400 easily adaptable to IBM  | <u>-</u> |
| CDC   |          |
| TRANSPORTABLE?:   |          |
| Machine Dependent Restrictions: none known  |          |
| ARLE CONTAINED  |          |
| SELF-CONTAINED?:  |          |
| Other Codes Required (name, purpose): Boltzmann Code. E-Beam Source Code  |          |
| ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  |          |
| Core Size (Octal Words)   Execution Time (sec, CDC 7600)  |          |
| Small Job: 60K  |          |
| Typical Job:  | -        |
| Large Job;  |          |
| Approximate Number of FORTRAN Lines: 1750   |          |
| COMMENTS:   |          |
| * Name generated for identification purpose.  | 9        |
|   |          |

CODE NAME: PSI LASER

| 1. CODE STRUCTURE                         | 3. LASING KINETICS MODEL                                |
|---|---|
| COORDINATE SYSTEM (√):                    | GENERAL (specify):                                      |
| Cartesian: V Expanding:                   | Lasing Species: Arbitrary                               |
| KINETICS GRID DIMENSIONALITY ( ):         | Number of Species: Arbitrary, typicall                  |
| I-D:                                      | Number of Reactions: Arbitrary                          |
| 3-D:                                      | Other Major Species Considered: Impuriti                |
| GAIN REGION SYMMETRY RESTRICTIONS:        | discharge lasers.                                       |
| Gain Vary Along Optical Axis:             |   |
| Flow Direction: V                         | IMPACT EXCITATION MODELED ( ):                          |
| KINETICS MODELED: Pulsed: V CW: V         | (Reference)   |
| NUMERICAL SCHEME USED IN RATE             | Vibrational:  |
| CALCULATION (√):                          | Electronic:   |
| Explicit:                                 | Others (specify);                                       |
| Implicit: V                               | Rotational  |
| Others (specify):                         | ENERGY TRANSFER MODES MODELED ( ):                      |
|   | (Reference)   |
| REFERENCE OF METHOD USED:                 | V-T:  |
|   | V-R:  |
|   | V-V:  |
| 2. PLASMA KINETICS MODEL                  | Others (specify):                                       |
| NUMBER OF SPECIES TREATED (specify):      | lasing Transition; P-Branch:                            |
| Number of Positive                        | R-Branch:   |
| Species:                                  | Single Line Model ( ):                                  |
| Number of Negative Species:               | Multi-Line Model (√):  Assumed Rotational Population    |
| Number of Neutral                         | Distribution State (1);                                 |
| Species:  REACTION MECHANISM MODELED (√): | Equilibrium:  |
| Primary fonization: (Reference)           | Nonequilibrium:   |
| E-Beam:                                   | Number of Laser Lines Modeled: Arbitrary                |
| Self-Sustained: 🗸                         | Source of Rate Coefficients Used in Code:<br>Literature |
| UV-Initiated:                             | TR-182  |
| Others (specify):                         |   |
|   | LINE PROFILE MODELS ( ):                                |
| Secondary Ionization (Reference)          | Doppler Broadening:                                     |
| Attachment:                               | Co. slonal Broadening:                                  |
| Detachment:                               | Collers (specify):                                      |
| Ion-Ion Recom-                            | Voigt   |
| Charge Transfer:                          | 4 RECIRCULATION CONTAMINANTS                            |
| Dissociation/                             | MODELED (√): none                                       |
| Recombination:                            | «: OH <sub>x</sub> :                                    |
| Others (specify):                         | NO <sub>x</sub> : HNO <sub>x</sub> :                    |
| Penning Ionization                        | Others (specify):                                       |
| Source of Rate Coefficients Used:         |   |
| Literature                                | REFERENCE FOR REACTION MECHANISM                        |
| DISCHARGE POWER INPUT MODELED (V):        | AND RATES:  |
| Uniform: V Non-Uniform: V (time onl       | OTHER UNIQUE FEATURES:                                  |
| E-Field:                                  | OTHER ORIGINE PERTORES:                                 |
| Others (specify):                         |   |
|   |   |
|   |   |

| DENICE COMPONENTS TREATED: Pulsed Electrical Power SINICIDAL PURPOSES(MAPPLICATIONS) OF CODE: model PEN's performance.  This is a general purpose circuit analysis code.  ASSESSMENT OF CAPABILITIES: excellent  DITHER UNIQUE FEATURES:  DIRIGINATOR/KEY CONTACT:  Name: E. Wheatley Organization: Rocketdyne Division of Rockwell, N.S. FA-28 Address: 6633 Canoga Ave., Canoga Pk 91304 Phone: 213-709-7136  VAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RF = Releted Publication):  U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. 1  Under Modification?:  Operational Currently?: X Under Modification?:  Purpose(s):  Ownership?: Rockwell Proprietary?: yes Machine Dependent Restrictions:  STATUS: Operational Currently SYSTEM (on which installed): CDC  TRANSPORTABLE?: Yes Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines:  | ODE NAME: RED       | AC TECHNICAL AREA(S):                                    |
|--|---------------------|--|
| PRINCIPAL PURPOSES()/APPLICATION(S) OF CODE: model PFN's performance.  This is a general purpose circuit analysis code.  ASSESSMENT OF CAPABILITIES:   |                     | TS TREATED: Pulsed Electrical Power                      |
| This is a general purpose circuit analysis code.  ASSESSMENT OF CAPABILITIES: excellent  ASSESSMENT OF LIMITATIONS; as good as input  OTHER UNIQUE FEATURES:  DRIGINATOR/KEY CONTACT;  Name; E, Wheatley Organization; Rocketdyne Division of Rockwell, M.S. FA-28 Address; 6633 Canoga Ave., Canoga Fk 91304 Phone; 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication); U; "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. 1  ATATUS: Operational Currently?: X Under Modification? Purpose(s):  Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed); CDC  TRANSPORTABLE?: Yes Machine Dependent Restrictions; SELF-CONTAINED?: Other Codes Required (name, purpose): DO  ESTIMATE OF RESOURCES REQUIRED FOR RUNS: Core Sire JOCtal Words)   Execution Time (sec, CDC 7600) Small Job; Typical Job; Large Job; Large Job; Approximate Number of FORTRAN Lines;  | PRINCIPAL PURPOS    | E(S)/APPLICATION(S) OF CODE: model PFN's performance.    |
| OTHER UNIQUE FEATURES:  DRIGINATOR/KEY CONTACT: Name: E. Wheatley Organization: Rocketdyne Division of Rockwell, M.S. FA-28 Address: 6633 Canoga Ave., Canoga Pk 91304 Phone: 213-709-7136  NVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related publication); U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. 1  STATUS: Operational Currently?: X Under Modification?: Purpose(s):  Ownership?: Rockwell Proprietary7: yes Machine Dependent Restrictions; SELF-CONTAINED?: Other Codes Required (name, purpose): DOE  STATUS: Core Size (Octal Words) Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;  | This is a gene      | ral purpose circuit analysis code.                       |
| OTHER UNIQUE FEATURES:  DRIGINATOR/KEY CONTACT: Name: E. Wheatley Organization: Rocketdyne Division of Rockwell, M.S. FA-28 Address: 6633 Canoga Ave., Canoga Pk 91304 Phone: 213-709-7136  NVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related publication); U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. 1  STATUS: Operational Currently?: X Under Modification?: Purpose(s):  Ownership?: Rockwell Proprietary7: yes Machine Dependent Restrictions; SELF-CONTAINED?: Other Codes Required (name, purpose): DOE  STATUS: Core Size (Octal Words) Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;  |                     |  |
| OTHER UNIQUE FEATURES:  DRIGINATOR/KEY CONTACT: Name: E. Wheatley Organization: Rocketdyne Division of Rockwell, M.S. FA-28 Address: 6633 Canoqa Ave., Canoqa Pk 91304 Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related publication); U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. organization of the property of th |                     |  |
| OTHER UNIQUE FEATURES:  DRIGINATOR/KEY CONTACT: Name: E. Wheatley Organization: Rocketdyne Division of Rockwell, M.S. FA-28 Address: 6633 Canoqa Ave., Canoqa Pk 91304 Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related publication); U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. organization of the property of th |                     |  |
| OTHER UNIQUE FEATURES:  DOTIGINATOR/REY CONTACT:  Name: E, Wheatley Organization: Rocketdyne Division of Rockwell, M.S. FA-28 Address: 6633 Canoga RVe., Canoga PK 91304 Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):  U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. of the Color | ASSESSMENT OF CA    | PABILITIES: excellent                                    |
| OTHER UNIQUE FEATURES:  DOTIGINATOR/REY CONTACT:  Name: E, Wheatley Organization: Rocketdyne Division of Rockwell, M.S. FA-28 Address: 6633 Canoga RVe., Canoga PK 91304 Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):  U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. of the Color |                     |  |
| OTHER UNIQUE FEATURES:  DOTIGINATOR/REY CONTACT:  Name: E, Wheatley Organization: Rocketdyne Division of Rockwell, M.S. FA-28 Address: 6633 Canoga RVe., Canoga PK 91304 Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):  U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. of the Color |                     |  |
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| DRIGINATOR/REY CONTACT; Name: E. Wheatley Organization: Rocketdyne Division of Rockwell, N.S. FA-28 Address: 6633 Canoga Ave., Canoga Pk 91304 Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication); U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. 1  STATUS: Operational Currently?: X Under Modification?: Purpose(s): Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: Yes Machine Dependent Restrictions; SELF-CONTAINED?: Other Codes Required (name, purpose): NO ESTIMATE OF RESOURCES REQUIRED FOR RUNS: Core Size [Octal Words)   Execution Time (sec, CDC 7600) Small Job: Typical Job: Large Job: Large Job: Approximate Number of FORTRAN Lines;  |                     |  |
| ORIGINATOR/KEY CONTACT:  Name: E. Wheatley Organization; Rocketdyne Division of Rockwell, M.S. FA-28 Address; 6633 Canoga Ave., Canoga Fk 91304 Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication); U; "REDAC User's Manual", Rockwell Internal Document, S77-749/501, Aug. 1  STATUS: Operational Currently?; X Under Modification?; Purpose(s):  Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed); CDC  TRANSPORTABLE?; yes Machine Dependent Restrictions;  SELF-CONTAINED?: Other Codes Required (name, purpose); no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS: Core Size [Octal Words)   Execution Time (sec, CDC 7600) Small Job; Typical Job; Large Job; Approximate Number of FORTRAN Lines;   |                     |  |
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| Address: 6633 Canoga Ave., Canoga Pk 91304 Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):  U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. of the properties of the  |                     |  |
| Phone: 213-709-7136  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):  U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. of the second of the secon | Organization:       | Rocketdyne Division of Rockwell, M.S. FA-28              |
| AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication); U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. 1  STATUS:  Operational Currently?; Vunder Modification?; Purpose(s);  Ownership?: Purpose(s);  Ownership?: Rockwell Proprietary?; yes MACHINE/OPERATING SYSTEM (on which installed); CDC  TRANSPORTABLE?: Other Codes Required (name, purpose); Other Codes Required (name, purpose); SELF-CONTAINED?: Other Codes Required FOR RUNS: Core Size [Octal Words]   Execution Time (sec, CDC 7600)  Small Job; Typical Job; Large Job; Approximate Number of FORTRAN Lines;   | Address: 0t         | 2.700-7136   |
| RP = Related Publication):  U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug.  STATUS:  Operational Currently?:  Yunder Modification?:  Purpose(s):  Ownership?:  Purpose(s):  MACHINE/OPERATING SYSTEM (on which installed):  CDC  TRANSPORTABLE?:  Yes  Machine Dependent Restrictions:  SELF-CONTAINED?:  Other Codes Required (name, purpose):  Other Codes Required (name, purpose):  Small Job:  Typical Job:  Large Job:  Approximate Number of FORTRAN Lines:  |                     |  |
| U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug.  STATUS:  Operational Currently?:X Under Modification?: Purpose(s):  Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed):CDC  TRANSPORTABLE?:yes  |                     |  |
| Operational Currently?: X Under Modification?: Purpose(s):  Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: Yes Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;   |                     |  |
| Operational Currently?: X Under Modification?: Purpose(s):  Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: Yes Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;   |                     |  |
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| Operational Currently?: X Under Modification?: Purpose(s):  Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: Yes Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;   |                     |  |
| Operational Currently?: X Under Modification?: Purpose(s):  Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: Yes Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;   |                     |  |
| Under Modification?: Purpose(s):  Ownership?: Rockwell Proprietary?: yes MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: yes Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS: Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;  | TATUS:              |  |
| Ownership?: Rockwell Proprietary?: yes  MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: yes Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;  | Operational Cu      | rrently?: X  |
| Ownership?: Rockwell Proprietary?: yes  MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: Yes     Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS:     Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines;   | Under Modifica      | tion?;   |
| Proprietary?: _yes  MACHINE/OPERATING SYSTEM (on which installed):   | Purpose(s           | :  |
| Proprietary?: _yes  MACHINE/OPERATING SYSTEM (on which installed):   |                     |  |
| Proprietary?: _yes  MACHINE/OPERATING SYSTEM (on which installed):   |                     |  |
| MACHINE/OPERATING SYSTEM (on which installed): CDC  TRANSPORTABLE?: yes  Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words) Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines:   |                     |  |
| TRANSPORTABLE?: Yes  Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose): no  ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   |                     | ~  |
| Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose):  OTHER CODES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines:   | MACHINE/OPERATI     | NG 5151EM (on which installed):                          |
| Machine Dependent Restrictions:  SELF-CONTAINED?: Other Codes Required (name, purpose):  OTHER CODES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines:   | TRANSPORTABLE?      | yes  |
| Other Codes Required (name, purpose):  |                     |  |
| Other Codes Required (name, purpose):  |                     |  |
| ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines:  | SELF-CONTAINED?     |  |
| ESTIMATE OF RESOURCES REQUIRED FOR RUNS:  Core Size (Octal Words)   Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines:  | Other Codes R       | equired (name, purpose):no                               |
| Core Size (Octal Words) Execution Time (sec, CDC 7600)  Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines:  |                     |  |
| Small Job: Typical Job: Large Job: Approximate Number of FORTRAN Lines:  | ESTIMATE OF RESC    | OURCES REQUIRED FOR RUNS:                                |
| Typical Job: Large Job: Approximate Number of FORTRAN Lines:   |                     | Core Size (Octal Words)   Execution Time (sec, CDC 7600) |
| Large Job: Approximate Number of FORTRAN Lines:  | Small Job;          |  |
| Approximate Number of FORTRAN Lines;   | Typical Job:        |  |
|  |                     |  |
|  |                     |  |
|  | COMMENTS:           |  |
|  |                     |  |

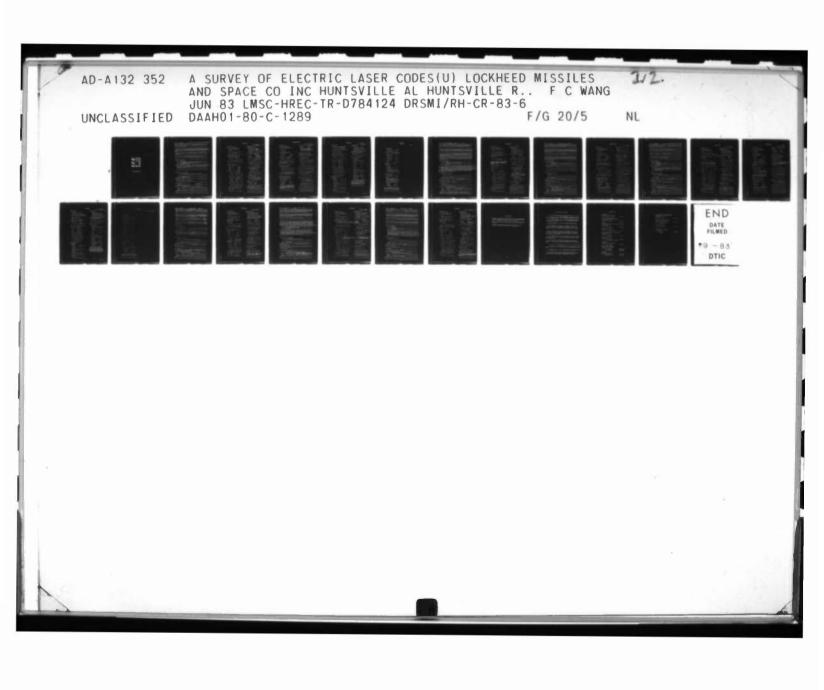
| CODE NAME:_      | STROBE                  | TECHNIC                                 | AL AREA(S):                            | Gas Dynamics                        |
|------------------|-------------------------|---|--|-------------------------------------|
|                  | ONENTS TREATED          |   |  |                                     |
|                  |                         |   |  | Duct, Cavity Acoustics              |
|                  | 21.1 0021(0), 11.1 2101 |   |  |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
| ASSESSMENT       | OF CAPABILITIES:        | Multidimensio                           | onal acous                             | tics caused by non-ideal            |
|                  | i.e. beam ducts         |   |  | 37 11011 2444                       |
|                  |                         | ,                                       |  |                                     |
|                  |                         |   |  |                                     |
| ASSESSMENT       | OF LIMITATIONS          | Incomplete bo                           | oundary co                             | ndition formulation at open         |
| end, uses        | constant pressu         | ire which is no                         | ot accurat                             | е.                                  |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
| OTHER UNION      | E FEATURES:             |   |  |                                     |
| O 111 EK 011 IQ0 | E I ER TORES.           |   |  |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
| ORIGINA TOP /    | KEY CONTACT:            |   |  |                                     |
|                  | B. Masson               |   |  |                                     |
|                  | tion; RDA               |   |  |                                     |
| Organiza         | ATO Box 9377            | Internationa                            | l Airport                              | Alb, NM 87119                       |
| Address          | (505) 243-5609          | THE CHIEF TO THE                        | · ···································· | 1110, 141 07117                     |
|                  |                         |   | <b>.</b>                               |                                     |
| RP = Rel         | lated Publication):     | T. L                                    | 1 = Ineory, (                          | J = User's Manual, L = Listing, and |
|                  | , · ·                   |   |  |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
| STATUS:          |                         |   |  |                                     |
|                  | nal Currently?:         | 28                                      |  |                                     |
| Under M          | odification?: yes       |   |  |                                     |
| Pur              | pose(s): Beam Du        | ict Model bein                          | g improved                             |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |
| Ownersh          | ip?: RDA                |   |  |                                     |
| Propriet         | ary?: No                |   |  |                                     |
|                  | ERATING SYSTEM          | on which installed):                    | CRAY I                                 |                                     |
|                  |                         |   |  |                                     |
| TRANSPORTA       | BLE?: Yes               |   |  |                                     |
| Machine          | Dependent Restriction   | ons: None                               |  |                                     |
|                  |                         |   |  |                                     |
| SELF-CONTAI      | NED?:                   |   |  |                                     |
|                  | odes Required (name     | . ourpose).                             | ~ r                                    | Plotter                             |
| 0                |                         | , | -                                      |                                     |
| ESTIMATE OF      | RESOURCES REQU          | IRED FOR SUNS.                          |  |                                     |
| ESTIMULTE OF     | Core Size (Oc           |   | ecution Time                           | (sec, CDC 7600)                     |
| Compli to        |                         | tal Words)                              | ecution Time                           | (sec, ebc 7000)                     |
| Small Jo         |                         |   |  |                                     |
| Typical          |                         |   |  |                                     |
| Large Jo         |                         |   |  |                                     |
| Approxi          | mate Number of FOR      | TRAN Lines:                             |  |                                     |
| COMMENTS:        | Report in prep          | aration.                                |  |                                     |
|                  |                         |   |  |                                     |
|                  |                         |   |  |                                     |

|   | CODE NAME: STROBE                                |
|---|--|
| I. CODE STRUCTURE                           | decontamination method treated ( $\checkmark$ ): |
| COORDINATE SYSTEM (V):                      | Scrubber:  |
| Cartesian: Expanding:                       | Shower:  |
| FLUID GRID DIMENSIONALITY (1):              | Gatalutia Paratan                                |
|   | Catalytic Reactor:                               |
| 1-D:  | Others (specify):                                |
| 2-D:  |  |
|   |  |
| Time Dependent: V                           | A ACCUSTIC ATTENNA TION AND TO                   |
| FLOW FIELD MODELED (√):  Compressible Flow: | 4. ACOUSTIC ATTENUATION MODEL                    |
|   | GENERAL FEATURES MODELED (√):  Single Pulse:     |
| Incompressible:                             |  |
| Viscous Flow:                               | DIMENSIONALITY TREATED (√):                      |
| No Flow:                                    | 1-D: 2-D: 3-D: V                                 |
| BASIC MODELING APPROACH (√):                | Time Dependent:                                  |
| Algebraic: Integral Method:                 | DISTURBANCE MODELED (1):                         |
| Finite Difference:                          | Pressure Wave: Entropy Wave:                     |
| Others (specify):                           | Others (specify):                                |
| REFERENCE FOR APPROACH USED:                | WAVE PROPAGATION TREATMENT (√):                  |
| MacCormack                                  | •  |
|   | Linear Wave:                                     |
|   | Others (specify):                                |
| 2. GAS DYNAMICS MODEL FEATURES:             |  |
| GAS SUPPLY MODELED ( ):                     | THEORETICAL BASIS: (Reference)                   |
| Mixture Preparation:                        |  |
| Mixture Injection:                          |  |
|   | NUMERICAL METHODOLOGY: (Reference)               |
| Nozzles:<br>Flow Plates: ✓                  |  |
| Others (specify):                           |  |
|   | ACOUSTIC ATTENUATORS CONSIDERED ( ):             |
| CAVITY INITIAL CONDITION DETERMINED         | Muffler: Heat Exchanger:                         |
| BY (specify): Input                         | Horn: Porous Wall:                               |
|   | Others (specify):                                |
| 3. EXHAUST RECIRCULATION MODEL              |  |
| GENERAL SYSTEM MODELED (√):                 |  |
| Open System: Closed System:                 | 5. MODEL EFFECTS ON OPTICAL MODES DUE<br>TO (√): |
| Closed Cycle:                               | Index of Refraction Variation?:                  |
| EXHAUST SYSTEM FEATURES (√):                | Other (specify):                                 |
| Pressure Recovery:                          | Other (appear) i.                                |
| Ejector System:                             |  |
| Compressor Fan:                             |  |
| Heat Exchanger:                             | OTHER INIOHE BEATHRES                            |
| Gas Make-Up:                                | OTHER UNIQUE FEATURES:                           |
|   |  |
| Others (specify): Absorbers                 |  |
|   |  |
|   |  |
|   |  |
|   |  |
|   |  |
|   |  |

| ASSESSMENT OF CAPABILITIES: Analysis of an electrically excited supersonic CO laser, with coupled molecular kinetics, plasma kinetics, gas dynamics, and optical extraction. (Simple one-dimensional models for gas dynamics and resonator.)  ASSESSMENT OF LIMITATIONS: Simplified treatment of gas dynamics and optical resonator.  OTHER UNIQUE FEATURES: Provides for multiple lasing transitions, and includes the effects of resonant self-absorption from overlapping transitions in a hig pressure gas system. Plasma kinetics are provided by Boltzmann equation, completely coupled to molecular kinetics and optical extraction.  ORIGINATOR/KEY CONTACT:  Name: William B. Lacina Organization: Northrop Research and Technology Center Address: One Research Park, Palos Verdes Estates, CA 90274 Phone: (213) 377-4811 ext. 362  AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):  "Supersonic Continuous Wave Carbon Monoxide Laser Development, Phase I. Vol I: CO Laser Kinetics Code. Vol. IV: Rates and Cross Sections, "Northrop Rept. #NFTC-75-25R, July 1975. #NRTC-75-50R, NRTC-76-18R. |
|---|
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| Vol I: CO Laser Kinetics Code. Vol. IV: Rates and Cross Sections, "Northrop Rept. #NFTC-75-25R, July 1975. #NRTC-75-50R, NRTC-76-18R.   |
| Rept. #NRTC-75-25R, July 1975. #NRTC-75-50R, NRTC-76-18R.   |
|   |
|   |
| (T,U,L) Miscellaneous papers.   |
|   |
| STATUS:   |
| Operational Currently?: Yes   |
| Under Modification?; NO   |
| Purpose(s):   |
|   |
|   |
| Ownership?: Northrop Research & Tech./ William B. Lacina  |
| Proprietary?: No. Public Domain   |
| MACHINE/OPERATING SYSTEM (on which installed): CDC 660  |
|   |
| TRANSPORTABLE?: yes   |
| Machine Dependent Restrictions: Yes   |
| SELF-CONTAINEDY YES   |
| Other Codes Required (name, purpose);   |
|   |
| ESTIMATE OF RESOURCES REQUIRED FOR RUNS;  |
| Core Size (Octal Words)   Execution Time (sec, CDC 7600)  |
| Small Job:  |
| Typical Job:  |
| Large Job:  |
| Approximate Number of FORTRAN Lines:  |
| COMMENTS:   |
|   |

CODE NAME: SUPERSONIC

| CODE STRUCTURE                       | 3. LASING KINETICS MODEL   |
|--------------------------------------|--|
| COORDINATE SYSTEM (√):               | GENERAL (specify):   |
| Cartesian: Expanding:                | Lasing Species: CO/N <sub>2</sub> /···X                          |
| KINETICS GRID DIMENSIONALITY (√):    | Lasing Species: CO/N <sub>2</sub> /···X  Number of Species: ~3   |
| 1-D:                                 | Number of Reactions:   |
| 3-D:                                 | Other Major Species Considered:                                  |
| GAIN REGION SYMMETRY RESTRICTIONS:   |  |
| Gain Vary Along Optical Axis:        |  |
| Flow Direction:                      | IMPACT EXCITATION MODELED ( ):                                   |
| KINETICS MODELED: Pulsea: V CW: V    | (Reference)  |
| NUMERICAL SCHEME USED IN RATE        | Vibrational:   |
| CALCULATION (V):                     | Electronic:  |
| Explicit:                            | Others (specify):  |
| implicit;                            |  |
| Others (specify):                    | ENERGY TRANSFER MODES MODELED (√):                               |
|                                      | (Reference)  |
|                                      |  |
| REFERENCE OF METHOD USED:            | V-T:   |
|                                      | V-R:<br>V-V:   |
|                                      | V=V: V   |
| PLASMA KINETICS MODEL                | Others (specify):  |
| NUMBER OF SPECIES TREATED (specify); | Lasing Transition: P-Branch:                                     |
| Number of Positive                   | R-Branch:  |
| Species:                             | Single Line Model (1):   |
| Number of Negative                   | Multi-Line Model (√):  |
| Species:                             | Assumed Rotational Population Distribution State ( $\sqrt{1}$ ): |
| Number of Neutral<br>Species:        | Equilibrium;   |
| REACTION MECHANISM MODELED (1):      | Nonequilibrium:  |
| Primary Ionization: (Reference)      | Number of Laser Lines  |
| E-Beam;                              | Modeled: ≤ 25  |
| Self-Sustained:                      | Source of Rate Coefficients Used in Code:                        |
| UV-Initiated:                        | Misc.  |
| Others (specify):                    |  |
|                                      | LINE PROFILE MODELS ( ):   |
| Secondary Ionization (Reference)     | Doppler Broadening:  |
| Attachment:                          | Collisional Broadening:  |
| Detachment:                          | Others (specify):  |
|                                      | (1)  |
| Ion-lon Recom-<br>bination:          |  |
| Charge Transfer:                     | 4. RECIRCULATION CONTAMINANTS                                    |
| Dissociation/                        | MODELED ( <b>√</b> ): none                                       |
| Recombination:                       | O <sub>X</sub> ; OH <sub>X</sub> ;                               |
| Others (specify):                    | NO <sub>x</sub> : HNO <sub>x</sub> :                             |
|                                      | Others (specify):  |
| Source of Rate Coefficients Used:    |  |
|                                      | REFERENCE FOR REACTION MECHANISM                                 |
| DISCHARGE POWER INPUT MODELED (1):   | AND RATES:   |
| Uniform; V Non-Uniform;              |  |
| E-Fteld: V                           | OTHER UNIQUE FEATURES:   |
|                                      |  |
| Others (specify):                    |  |





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

| CODE NAME:                            | TDFI-EDL                              | TECHN               | ICAL AREA(S):     | Optics,     | Kinetics,      | Gas Dynamics |
|---------------------------------------|---------------------------------------|---------------------|-------------------|-------------|----------------|--------------|
| DEVICE COMPO                          | NENTS TREATED                         | cavity              |                   |             |                |              |
|                                       | RPOSE(S)/APPLIC                       |                     | E: Estimate       | performa    | nce trends     | of CW        |
| EDL with ur                           | stable resona                         | tor.                |                   |             |                |              |
|                                       |                                       |                     | <del></del>       |             |                |              |
|                                       |                                       |                     |                   |             |                |              |
| ASSESSMENT                            | F CAPABILITIES:                       | Two-Dimensio        | nal Fresnel       | integral    | (cylindri      | cal optics)  |
|                                       | ed to detailed                        |                     |                   |             |                |              |
| model.                                |                                       |                     |                   |             |                |              |
|                                       |                                       |                     |                   |             |                |              |
| ASSESSMENT O                          | F LIMITATIONS:_                       | Cavity analy        | sis restric       | ted to cy   | lindrical      | mirror       |
| configurat                            | ions.                                 |                     |                   |             |                |              |
|                                       |                                       |                     |                   |             |                |              |
|                                       |                                       |                     | 7                 |             |                |              |
| OTHER UNIQUE                          | FEATURES: FU                          | lly coupled b       | cinetics and      | wave opt    | ics code.      |              |
|                                       |                                       |                     |                   |             |                |              |
|                                       |                                       |                     |                   |             |                |              |
| ORIGINATOR/K                          | EY CONTACT:                           |                     |                   |             |                |              |
| Name:                                 | Jurgen Thoene                         | es                  |                   |             |                |              |
| 1/2                                   | on: Lockheed-                         | Huntsville Re       | esearch & En      | gineering   | Center         |              |
|                                       | 4800 Bradford                         |                     |                   | 807         |                |              |
|                                       | (205) 837-1800                        |                     |                   |             |                |              |
| AVAILABLE DO                          | CUMENTATION (                         | Please specify, us  | e T = Theory, U   | = User's Ma | anual, L = Lis | ting, and    |
| RP = Rela                             | ted Publication): _<br>Part I - Theor | J. Thoenes, S       | C. Kurzius        | M.L. Pe     | arson EDL      | Periormance  |
|                                       | R-75-2, June                          |                     | Guide, 0.3        | . Almy MI   | SSITE COM      | land,        |
| IN NO C.                              | 13 2, oune .                          | 13/3: (1 4 0)       |                   |             |                |              |
|                                       |                                       |                     |                   |             |                |              |
| · · · · · · · · · · · · · · · · · · · |                                       |                     |                   |             |                |              |
| STATUS:                               |                                       |                     | 4                 |             |                |              |
|                                       | al Currently?:                        | yes                 |                   |             |                |              |
| Under Mo                              | diffication?:                         |                     |                   |             |                |              |
| Purpo                                 | se(s): Require                        | es updating;        | not used for      | several     | years.         |              |
|                                       |                                       |                     |                   |             |                |              |
|                                       |                                       |                     |                   |             |                |              |
| Ownership                             | ?: Lockheed-I                         | Huntsville          | <del>~~~~~~</del> |             |                |              |
|                                       | ry?: No                               |                     |                   |             |                |              |
| MACHINE/OPE                           | RATING SYSTEM                         | (on which Installed | 1):               |             |                |              |
| TRANSPORTAR                           | LE2. VAS                              |                     |                   |             |                |              |
| TRANSPORTAB                           | Dependent Restrict                    | iona. CDC 660       | 0/7600            |             |                |              |
| Maciline                              | rependent Restrict                    |                     |                   |             |                |              |
| SELF-CONTAIN                          | ED?:                                  |                     |                   |             |                |              |
| Other Cod                             | es Required (name                     | , purpose):         | : :-              | ron Kinet   | ics            |              |
| Code                                  |                                       |                     |                   |             |                |              |
| ESTIMATE OF                           | RESOURCES REQU                        | UIRED FOR RUNS      | :                 |             |                |              |
|                                       | Core Size (Oc                         | tal Words)   F      | xecution Time     | sec, CDC 76 | 00)            |              |
| Small Job                             |                                       |                     | 100               |             |                |              |
| Typical Jo                            | ob: 210                               |                     | 100               |             |                |              |
| Large Job                             |                                       |                     | <del></del>       |             |                |              |
| the same and the same of the same of  | ate Number of FO                      | RTRAN Lines:        | 5100              |             |                |              |
| COMMENTS: _                           |                                       |                     |                   |             |                |              |
|                                       |                                       |                     |                   |             |                |              |

|  | CODE NAME: EDL  |
|--|---|
|  | (TDFI-EDL)  |
| I. CODE STRUCTURE                                    | 3. LASING KINETICS MODEL                              |
| COORDINATE SYSTEM (V):                               | GENERAL (*pecify):                                    |
| Cartesian: V Expanding:                              | Number of Species: Input                              |
| KINETICS GRID DIMENSIONALITY (√):                    | realiser of Species;                                  |
| 1-D: 2-D:  | Number of Reactions: Input                            |
| 3-D:   | Other Major Species Considered: N2, He,               |
| GAIN REGION SYMMETRY RESTRICTIONS:                   |   |
| Gain Vary Along Optical Axis:                        |   |
| Flow Direction: V                                    | IMPACT EXCITATION MODELED ( <b>√</b> ):               |
| KINETICS MODELED: Pulsed: CW:                        | (Reference)   |
| NUMERICAL SCHEME USED IN RATE CALCULATION (√):       | Vibrational:  |
| Explicit. / (flow field)                             | Electronic:   |
| Implicit:  (kinetics)                                | Others (specify): Ionization                          |
| Others (specify):                                    | ENERGY TRANSFER MODES MODELED (√):                    |
|  | (Reference)   |
|  | V-T: V same   |
| REFERENCE OF METHOD USED:                            | V-R:  |
|  | v-v: 🗸  |
|  | Others (specify):                                     |
| 2. PLASMA KINETICS MODEL                             | Lasing Transition: P-Branch:                          |
| NUMBER OF SPECIES TREATED (specify);                 | R-Branch;   |
| Number of Positive Species: Input                    | Single Line Model (V):                                |
|  | Multi-Line Model (√):                                 |
| Number of Negative Input Species:  Number of Neutral | Assumed Rotational Population Distribution State (√): |
| Species: Input                                       | Equilibrium:  |
| REACTION MECHANISM MODELED ( ):                      | Nonequilibrium:                                       |
| Primary lonization: (Reference)                      | Number of Laser Lines                                 |
| E-Beam: V   same                                     | Modeled:  |
| Self-Sustained:                                      | Source of Rate Coefficients Used in Code:             |
| UV-Initiated:  | same  |
| Others (specify):                                    |   |
|  | LINE PROFILE MODELS ( ):                              |
| Secondary Ionization (Reference)                     | Doppler Broadening:                                   |
| Attachment: V same                                   | Collisional Broadening:                               |
| Detachment:  | Others (specify): Voigt Function                      |
| Ion-Ion Recom-                                       | · · · · · · · · · · · · · · · · · · ·                 |
| bination:  | 4. RECIRCULATION CONTAMINANTS                         |
| Charge Transfer:                                     | MODELED (1):  |
| Dissociation/ Recombination:                         | O <sub>x</sub> : V OH <sub>x</sub> : V                |
| Others (specify):                                    | NO: V HNO: V  |
|  | Others (specify):                                     |
| Source of Rate Coefficients Used;                    |   |
|  | REFERENCE FOR REACTION MECHANISM                      |
| DISCHARGE POWER INPUT MODELED (1):                   | AND RATES: same                                       |
| Uniform: V Non-Uniform:                              |   |
| E-Field:   | OTHER UNIQUE FEATURES:                                |
| Others (specify):                                    |   |
|  |   |
|  |   |
|  |   |

|  | CODE NAME:                            |
|--|---------------------------------------|
|  | (TDFI-EDL)                            |
| CODE STRUCTURE   | DECONTAMINATION METHOD TREATED ( ):   |
| COORDINATE SYSTEM (V):   | Scrubber:                             |
| Cartesian: V Expanding:  | Shower:                               |
| FLUID GRID DIMENSIONALITY ( ):   | Catalytic Reactor:                    |
| I-D:   | Others (specify): Modeled by          |
|  | adjusting mix composition             |
| 2-D:   |                                       |
| 3-D:   |                                       |
| Time Dependent:  |                                       |
| LOW FIELD MODELED (V):   | 4. ACOUSTIC ATTENUATION MODEL         |
| Compressible Flow:   | GENERAL FEATURES MODELED (√):         |
| Incompressible:  | Single Pulse: Repetitive Pulse:       |
| Viscous Flow:  | DIMENSIONALITY TREAL D ( ):           |
| No Flow:   | 1-D: 2-D: 3-D:                        |
| BASIC MODELING APPROACH (1):   | Time-Dependent:                       |
| Algebraic: Integral Method:  | DISTURBANCE MODELED (V):              |
| Finite Difference: V   | Pressure Wave: Entropy Wave:          |
| Others (specify):  | Others (specify):                     |
| Others (spectry).  | Others (spectry):                     |
| REFERENCE FOR APPROACH USED:   | WAVE PROPAGATION TREATMENT (√):       |
| Euler integration  | Linear Wave:                          |
|  |                                       |
|  | Nonlinear Wave:                       |
| The second secon | Others (specify):                     |
| GAS DYNAMICS MODEL FEATURES:   |                                       |
| GAS SUPPLY MODELED (♥):  | THEORETICAL BASIS: (Reference)        |
| Mixture Preparation;   |                                       |
| Mixture Injection;   |                                       |
| Nozzles:   | NUMERICAL METHODOLOGY: (Reference)    |
| Flow Plates:   |                                       |
| Others (specify):  |                                       |
|  | ACOUSTIC ATTENUATORS CONSIDERED ( ):  |
| CAVITY INITIAL CONDITION DETERMINED  | Muffler: Heat Exchanger:              |
| BY (specify): Specified (input)  | Horn: Porous Wall:                    |
|  | Others (specify):                     |
| XHAUST/RECIRCULATION MODEL   |                                       |
| GENERAL SYSTEM MODELED (1):  |                                       |
|  | 5. MODEL .FFECTS ON OPTICAL MODES DUE |
| Open System: Closed System:  | TO C                                  |
| Closed Cycle:  | inaex of Refraction Variation?        |
| XHAUST SYSTEM FEATURES (√):  | Other (specify): Random noise         |
| Pressure Recovery:   |                                       |
| Ejector System:  |                                       |
| Compressor/Fan:  |                                       |
| Heat Exchanger:  | ER UNIQUE FEATURES:                   |
| Gas Make-Up:   |                                       |
| Others (specify): Circulator analysis  |                                       |
| requires specification of temp. and  |                                       |
| flow velocity as function of time  |                                       |
| around loop.   |                                       |
| alound loops   |                                       |
| \  |                                       |
|  |                                       |
|  |                                       |

# OPTICS CODE

CODE NAME: FICP

|   | (TDFI-EDL)  |
|---|---|
| CODE STRUCTURE                            | CONVERGENCE ( <b>√</b> ):                             |
| BASIC TYPE (V):                           | Technique:  |
| Physical Optics: FRESNEL INTEGRAL         | Power Comparison:                                     |
| Geometrical:                              | Field Comparison:                                     |
| Constant Gain: Floating Gain:             | Others (specify):                                     |
| FIELD (POLARIZATION) REPRESENTATION ( ):  | Acceleration Algorithms Used?:                        |
| Scalar:                                   | Technique:  |
| Vector:                                   | MULTIPLE EIGENVALUE/EIGENVECTOR                       |
| COORDINATE SYSTEM (V):                    | EXTRACTOR ALGORITHMS ( ):                             |
| Cartesian:                                | Prony:  |
| Expanding (specify):                      | Others (specify):                                     |
| TRANSVERSE GRID DIMENSIONALITY (specify): |   |
| One-Dimensinnal:                          | 3. RESONATOR MODELING FEATURES                        |
| Two-Dimensional:                          | CONTRACT CARABILITIES                                 |
|   | GENERAL CAPABILITIES:                                 |
| FIELD SYMMETRY RESTRICTIONS?:             | Stability ( ):  |
|   | Stable Resonators:                                    |
| MIRROR SHAPE(S) ALLOWED ( ):              | Unstable Resonators: V                                |
| Square:                                   | Type ( <b>√</b> )                                     |
| Rectangular:                              | Standing Wave:  |
| Circular:                                 | Traveling Wave (Ring):                                |
| Elliptical:                               | Reverse   |
| Strip:                                    | Traveling   |
| Arbitrary:                                | Wave:   |
| CONFIGURATION FLEXIBILITY (♥):            | Branch (V):   |
| Fixed, Single Resonator Geometry;         | Positive;   |
|   | Negative;   |
| Fixed, Multiple Resonator Geometries;     | Optical Element Models Included (√):                  |
|   | Flat Mirrors:   |
| Modular, Multiple Resonator Geometries:   | Spherical Mirrors:                                    |
| Others (describe):                        | Cylindrical Mirrors:                                  |
|   | Telescopes:   |
|   | Scraper Mirrors:                                      |
| PROPAGATION TECHNIQUE                     | Deformable Mirrors:                                   |
| (√all that apply):                        | Spatial Filters:                                      |
| Fresnel Integral Algorithms:              | Gratings (specify type):                              |
| With Kernel Averaging:                    | Other Elements (specify): Focusing output mirro       |
| Gaussian Quad-<br>rature:                 | PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List): |
| Fast Fourier Transform (FFT):             | Unstable resonator with focused oblique output beam.  |
| Fast Hankel Trans-<br>form (FHT):         |   |
| Gardener-<br>Fresnel-                     |   |
| Kirchhoff (GFK):                          |   |
| Others (specify):                         |   |
| Finite Difference Algorithms              |   |

# OPTICS CODE

CODE NAME TO SEE .

(Concluded)

| GAIN MODELS (√):                                |                  |
|---|------------------|
| Bare Cavity Only:                               |                  |
| Simple Saturated Gain;                          |                  |
| Detailed Model (See<br>Section 3 in Kinetics Co | ode)             |
| BARE CAVITY FIELD MOD                           | IFIER MODELS (   |
| Mirror Tilt:                                    |                  |
| Mirror Decentration:                            |                  |
| Aberrations/Thermal Distortion:                 |                  |
| Arbitrary:                                      |                  |
| Selected (specify):                             |                  |
| Reflectivity Loss:                              |                  |
| Output Coupler Edges                            |                  |
| Rolled:   |                  |
| Serrated;                                       |                  |
| Other:  |                  |
| LOADED CAVITY FIELD M<br>MODELS (√):            | ODIFIER          |
| Refractive Index Variation;                     |                  |
| Gas Absorption;                                 |                  |
| Overlapped Beams (for flux updating):           |                  |
| Number of Overlaps<br>Allowed:                  |                  |
| Others: Random no and starter                   | ise option       |
|   |                  |
| FAR FIELD MODELS ( ):                           |                  |
| Beam Steering Removal                           | l:               |
| Optimal Focal Search:                           | -                |
| Beam Quality:                                   |                  |
| Atmospheric Propagation                         | on               |
| Others: Non-Amplif focused output b             |                  |
| Tocused output b                                | cail.            |
| BEAM CONTROL SYSTEM                             | MODELED (√):     |
| Pointer/Tracker<br>Subsystem:                   |                  |
| Beam Jitter:                                    |                  |
| Autoalignment:                                  |                  |
| Target Model: Motion:                           | Effects:         |
|   | (e.g., Beam/Mode |

| ١ | i | 1 |  |
|---|---|---|--|

| CODE NAME: TEA  | Laser Kinetics TFO                                    | CHNICAL AREA(S): Kinetics  |
|-----------------|---|--|
| DEVICE COMPONE  | NTS TREATED: Laser                                    | CODE: To model the laser kinetics of a   |
| pulsed 10.6     | n CO, laser and to pr                                 | edict the performance of the laser.  |
|                 |   |  |
|                 |   |  |
| ASSESSMENT OF C | APABILITIES: <u>Can handl</u><br>re and pressure, and | e gas mixtures of CO2: N2: He: H2O: H2 at pulse lengths from one to twenty microseconds                |
| ASSESSMENT OF I | INITATIONS. IS one-di                                 | mensional, can only model stable resonators,   |
|                 |   | which Boltzmann equilibrium for the  |
|                 |   | proximation, and the rotational and kinetic  |
| temperatures    | are the same.   |  |
| OTHER UNIQUE FE | ATURES: A six-temper                                  | ature kinetic model is used which includes   |
| E/N-dependent   | electrical excitatio                                  | n and 29 temperature-dependent collisional   |
| relaxation ra   | tes.  |  |
| ORIGINATOR/KEY  | CONTACT:  |  |
| Name: Lyl       |   |  |
|                 | Westinghouse Elect                                    | ric Corporation  |
| Address: 1      | 310 Beulah Rd., Pitts                                 | burgh, PA 15668  |
| Phone: 4        | 12-256-5833   |  |
| AVAILABLE DOCU  | MENTATION (Please specify                             | use T = Theory, U = User's Manual, L = Listing, and ylor, L.A. Weaver, and R.W. Liebermann, "An Electr |
| RP = Related    | acer Kinetics Model                                   | I. Theoretical Formulation, "Westinghouse Paper  |
| 18-1C2-ADLAS-P1 | (1978) T: L.H. Ta                                     | ylor and L.A. Weaver, "An Electric Discharge CO  |
| aser Kinetics   | Model. Il. Collisiona                                 | 1 Rates, "Westinghouse Paper 78-1C2-ADLAS-P2 (1978   |
| J: L.H. Taylor  | , R.W. Liebermann, an                                 | d L.A. Weaver, "User's Manual for the Westinghouse   |
| ransversely Ex  | cited Atmospheric (TE                                 | A) CO <sub>2</sub> Laser Kinetics Computer Program,"   |
| Vestinghouse Re | port 75-9C2-LASEX-R2                                  | (1975).  |
|                 | urrently?: Yes  |  |
|                 | ation?: No  |  |
|                 | s):   |  |
|                 |   |  |
|                 |   |  |
|                 | U. S. Government                                      |  |
| Proprietary?:   |   | 11-12 11 11 106 and CDC-7600   |
| MACHINE/OPERA   | .ING SYSTEM (on which thata                           | lled): <u>U-1106</u> and CDC-7600  |
| TRANSPORTABLE   | Yes   |  |
|                 | ndent Restrictions: FORTF                             | NAN IV   |
|                 | , yes   |  |
| SELF-CONTAINED  |   |  |
| Other Codes I   | Required (name, purpose):                             |  |
| ESTIMATE OF RES | OURCES REQUIRED FOR RU                                | JNS:   |
|                 | Core Size (Octal Words)                               | Execution Time (sec, CDC 7600)   |
| Small Job:      |   |  |
| Typical Job:    | 14501   | 7 sec, CDC-7600  |
| Large Job:      |   |  |
| Approximate     | Number of FORTRAN Lines:                              | 736  |
| COMMENTS:       |   |  |
| Fabry-Perot (   | Cavity modeled using (                                | geometric optics with floating gain.   |

CODE NAS

| CODE STRUCTURE   | 3. LASING KINETICS MODEL                              |
|--|---|
| COORDINATE SYSTEM (♥):   | GENERAL (*pecify):                                    |
| Cartesian: V Expanding:  | Lasing Species: CO2                                   |
| KINETICS GRID DIMENSIONALITY ( ):  | Number of Species: 5                                  |
| 1-D: <u>V</u> 2-D:   | Number of Reactions: 29                               |
| 3-D:   | Other Major Species Considered:                       |
| GAIN REGION SYMMETRY RESTRICTIONS:   | He, $N_2, H_2O$ , $H_2$                               |
| Gain Vary Along Optical Axis: no   |   |
| Flow Direction: <u>no</u> KINETICS MODELED: Pulsed: <u>V</u> CW: <u>V</u>  | IMPACT EXCITATION MODELED (  (Reference)              |
| NUMERICAL SCHEME USED IN RATE  | Vibrational:  |
| CALCULATION ( ):   | Electronic:   |
| Explicit:  | Others (specify):                                     |
| Implicit:  |   |
| Others (specify): Hamming  | ENERGY TRANSFER MODES MODELED ( ): (Reference)        |
|  | v-T; ✓ 1  |
| REFERENCE OF METHOD USED: R. W. Harming,   | V-R:  |
| Numerical Methods for Engineers and  | V-V: V  |
| Scientists (1962).   | Others (specify):                                     |
| PLASMA EINETICS MODEL  | Lasing Transition: P-Branch:                          |
| NUMBER OF SPECIES TREATED (specify):   | R-Branch;   |
| Number of Positive Species:  | Single Line Model ( ):                                |
| Number of Negative   | Multi-Line Model (√):                                 |
| Species: Number of Neutral   | Assumed Rotational Population Distribution State ( 1: |
| Species:   | Equilibrium:  |
| REACTION MECHANISM MODELED (√):  | Nonequilibrium:                                       |
| Primary Ionization: (Reference) E-Beam:  | Number of Laser Lines<br>Modeled: <b>Several</b>      |
| Self-Sustained:  | Source of Rate Coefficients Used in Code:             |
| UV-Initiated: V  | Westinghouse Paper 78-1C2-ADLAS-(1978)                |
|  | LINE PROFILE MODELS (1):                              |
| Secondary Ionization (Reference)   | Dopolar Broadening:                                   |
| Attachment:  | Col sional Broadening:                                |
| Detachment:  | rs (specify);   |
| Ion-Ion Recom-   |   |
| bination;  |   |
| Charge Transfer:   | 4. RECIRCULATION CONTAMINANTS                         |
| Dissociation/<br>Recombination:  | MODELEU (✓): none  OH <sub>x</sub> :                  |
| Others (specify);  | NO <sub>x</sub> : HNO <sub>x</sub> :                  |
|  | Others (specify):                                     |
| Source of Rate Coefficients Used:  |   |
| American Company of the Company of t | REFERENCE FOR REACTION MECHANISM                      |
| DISCHARGE POWER INPUT MODELED (1):   | AND RATES:  |
| Uniform: V Non-Uniform:  |   |
| E-Field:   | OTHER UNIQUE FEATURES:                                |
|  |   |

| CODE NAME: TEL    | SAT TECHNICAL AREA(S): Gas Dynamics   |
|-------------------|---|
| DELLICE COMPONEN  | TO TREATED. Overall System Characteristics                                    |
| PRINCIPAL PURPOS  | E(S)/APPLICATION(S) OF CODE: Study steady state and transient                 |
| Thermodynamic a   | nd Fluid Dynamic System Performance.  |
|                   |   |
|                   |   |
|                   | PABILITIES: 1-D time dependent assessment of thermodynamic and                |
| fluid dynamic r   | performance of laser components and their interactions within                 |
| the laser syste   |   |
|                   |   |
| ASSESSMENT OF LIN | MITATIONS: limited to 1-D problems.   |
|                   |   |
|                   |   |
|                   |   |
| OTHER UNIQUE FEA  | TURES: Developed in "building block" format and easily                        |
|                   | ifferent systems (i.e. closed or open loop) can also be used                  |
| to model non-El   | JL Systems.   |
|                   |   |
| ORIGINATOR/KEY C  |   |
|                   | R&D Associates  |
| Organization:     | 9377 International Airport Albuquerque, NM 87119                              |
| Address:          | (505) 844-8446  |
|                   | ENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and |
| RP = Related P    | Publication): T, L, RP  |
| X                 |   |
|                   |   |
|                   |   |
|                   |   |
|                   |   |
| STATUS:           |   |
| Operational Cu    | rrently?: yes   |
| Under Modifica    | tion?:  |
| Purposeis         | la  |
|                   |   |
|                   |   |
|                   | R&D Associates  |
| Proprietary?:     |   |
| MACHINE/OPERATI   | NG SYSTEM (on which installed): CRAY-1  |
|                   | yes   |
| TRANSPORTABLE?:   | none  |
| Machine Depen     | dent Restrictions:  |
| SELF-CONTAINED?:  |   |
|                   | equired (name, purpose); none   |
| Outer Codes K     | squireu (manie, pur pose);  |
| ESTIMATE OF RESC  | OURCES REQUIRED FOR RUNS:   |
|                   | Core Size (Octal Words)   Execution Time (sec, CDC 7600)                      |
| Small Job:        | Anna facel CDO (Anna)   |
| Typical Job:      | 68096 (Version 1) 44 sec  |
| Large Job;        | 118272 (Version 2) 154 sec  |
|                   | umber of FORTRAN Lines:   |
| COMMENTS:         |   |
|                   |   |
|                   |   |

### GAS DYNAMICS CODE

CODE NAME: TELSAT DECONTAMINATION METHOD TREATED : J :: Scrubber: Shower: Catalytic Reactor: Others (specify): \_\_ 4. ACOUSTIC ATTENUATION MODEL GENERAL FEATURES MODELED (√): Single Pulse: Repetitive Pulse: DIMENSIONALITY TREALED ( ): 1-D:\_\_\_\_\_\_3-D:\_\_\_ Time-Dependent: DISTURBANCE MODELED (1): Pressure Wave: \_\_\_\_ Entropy Wave: \_\_\_\_ Others (specify): WAVE PROPAGATION TREATMENT (√): Linear Wave: Nonlinear Wave: Others (specify): \_\_\_ THEORETICAL BASIS: (Reference) NUMERICAL METHODOLOGY: (Reference) ACOUSTIC ATTENUATORS CONSIDERED ( 1: Muffler: \_\_\_\_ Heat Exchanger: \_\_\_ Horn: \_\_\_\_ Porous Wall: \_\_\_\_ Others (specify): 5. MODEL EFFECTS ON OPTICAL MCDES DUE index of Refraction Variation?:\_\_\_\_\_ Other (specify): TER UNIQUE FEATURES:

| 1. CODESTRUCTURE  |
|---|
| COORDINATE SYSTEM (V):                                  |
| Cartesian: Expanding:                                   |
| FLUID GRID DIMENSIONALITY ( ):                          |
| 1-D:  |
| 2-D:  |
| 3-D:  |
| Time Dependent:   |
| FLOW FIELD MODELED (1):                                 |
| Compressible Flow:                                      |
| Incompressible:   |
| Viscous Flow:   |
| -   |
| No Flow:  |
| BASIC MODELING APPROACH (√):                            |
| Algebraic: Integral Method:                             |
| Finite Difference:                                      |
| Others (specify):                                       |
|   |
| REFERENCE FOR APPROACH USED:                            |
| Blackburn-Fluid Power Control                           |
|   |
|   |
| 2. GAS DYNAMICS MODEL FEATURES:                         |
| GAS SUPPLY MODELED (V):                                 |
| Mixture Preparation:                                    |
| Mixture Injection:                                      |
| Nozzles:  |
| Flow Plates:  |
| Others (specify):                                       |
| Others (specify):                                       |
| CAVITY INITIAL CONDITION DETERMINED BY (specify): Input |
|   |
| 3. EXHAUST/RECIRCULATION MODEL                          |
| GENERAL SYSTEM MODELED (♥):                             |
| Open System; Closed System;                             |
| Closed Cycle:   |
| EXHAUST SYSTEM FEATURES ( ):                            |
| Pressure Recovery:                                      |
| Ejector System:   |
| Compressor/Fan:   |
| Heat Exchanger:   |
| Gas Make-Up:  |
| Others (specify): Nozzles, ducting                      |
| turbine   |
|   |
|   |
|   |
|   |
|   |

| CODE NAME:       | UNSEDL2                            | TECHNICAL AREA(S): Optics/Kinetics/Gas Dynamic             |
|------------------|------------------------------------|--|
| DEVICE COMPO     | NENTS TREATED:                     | EDI.   |
| PRINCIPAL PU     | RPOSE(S)/APPLICATION(S             | or cope: Time dependent behavior of CW CO2.                |
| EDL with mo      | ode media instabili                | су   |
|                  |                                    |  |
|                  |                                    |  |
| ASSESSMENT O     | F CAPABILITIES: 2-D                | Flow + kinetics; FFT optics                                |
|                  |                                    |  |
| ASSESSMENT O     | F LIMITATIONS: Ver                 | y expensive to run   |
|                  |                                    |  |
| OTHER UNIQUE     | FEATURES: Dynamic                  | Dimensioning   |
|                  |                                    |  |
| ORIGINATOR/K     |                                    |  |
| Name:            | Ted Salvi                          |  |
|                  | ion: AFWL/ARAO<br>Kirtland AFB, NM | 87117  |
| Address:         | 505-844-0256                       | 0.11.  |
|                  | CUMENTATION (Please sp             | ecify, use T = Theory, U = User's Manual, L = Listing, and |
| RP = Rela<br>U,L | ted Publication);                  |  |
|                  | Jumper, G.Y., Hines,               | J.D., and Salvi, T.C. & Riker, J.F.,                       |
|                  |                                    | ical Prediction of CO, Electric Discharge                  |
|                  | Laser Performance".                |  |
|                  |                                    |  |
| STATUS:          |                                    |  |
| Operation        | al Currently?: yes                 |  |
| Under Mo         | dification?: no                    |  |
| Purp             | ose(s): Not currently              | being used   |
|                  |                                    |  |
|                  | p?: USAF                           |  |
|                  | ry?; NO<br>RATING SYSTEM (on which | installed). CDC 7600 (Cyber 176)                           |
|                  |                                    |  |
|                  | LE?: no                            | O Parameter Language FIRM                                  |
| Machine          | Dependent Restrictions:            | O; Assembly language FFT                                   |
| SELF-CONTAIN     | IED?:                              |  |
| Other Cod        | les Required (name, purpos         | e);  |
| ESTIMATE OF      | RESOURCES REQUIRED FO              | OR RUNS:   |
|                  |                                    | Execution Time (sec, CDC 7600)                             |
| Small Job        |                                    |  |
| Typical J        |                                    |  |
| Large Joi        | eate Number of FORTRAN L           | inee. 10,000   |
|                  | ate Number of FORTRAN L            | ines;  |
| COMMENTS         |                                    |  |
|                  |                                    |  |

# KINETICS CODE

| COORDINATE SYSTEM ( ):  Cartesian:   | LASING KINETICS MODEL  GENERAL (specify):  Lasing Species: CO <sub>2</sub> (001)  Number of Species: 3  Number of Reactions: 6  Other Major Species Considered: |
|--|---|
| COORDINATE SYSTEM (1):  Cartesian:   | GENERAL (specify):  Lasing Species: CO <sub>2</sub> (001)  Number of Species: 3  Number of Reactions: 6   |
| Cartesian:Expanding:   | Lasing Species: CO <sub>2</sub> (001)  Number of Species: 3  Number of Reactions: 6   |
| KINETICS GRID DIMENSIONALITY ( ):  1-D: 2-D:  3-D:  GAIN REGION SYMMETRY RESTRICTIONS:  Cain Vary Along Optical Axis:Multiple sheet  Flow Direction: | Number of Species: 3  Number of Reactions: 6  |
| 1-D: 2-D:  | Number of Reactions: 6  |
| 3-D:   |   |
| GAIN REGION SYMMETRY RESTRICTIONS:  Gain Vary Along Optical Axis:Multiple sheet  Flow Direction:   | Other Major Species Considered:   |
| Gain Vary Along Optical Axis:Multiple sheet Flow Direction:  |   |
| Flow Direction:  |   |
|  |   |
| KINETICS MODELED: Pulsed: V CW: V (Time Dep  | IMPACT EXCITATION MODELED (√):  |
|  | (Reference)   |
| NUMERICAL SCHEME USED IN RATE CALCULATION (1):   | Vibrational: Y Electronic:  |
| Explicit;  | Others (specify);   |
| Implicit:  | Others (specify);   |
| Others (specify):  | ENTERCY TRANSFER MODES MODELED A L  |
|  | ENERGY TRANSFER MODES MODELED ( ( Reference)  |
| Ma Carracki a  | V-T: V  |
| REFERENCE OF METHOD USED: MacCormack's   | V-R: V  |
| Fluid Dyanmic, extended to kinetics  | V-V: V  |
|  | Others (specify):   |
| PLASMA KINETICS MODEL Energy levels:   | Lasing Transition: P-Branch:  |
| NUMBER OF SPECIES TREATED (specify): E   |   |
| Number of Positive   | R-Pranch:   |
| Species: E lower   | Single Line Model (♥):  |
| Number of Negative E   | Multi-Line Model (√);   |
| Species: N2  | Assumed Rotational Population Distribution State $(\sqrt{\cdot})$ :   |
| Species:   | Equilibrium:  |
| REACTION MECHANISM MODELED (√1:  | Nonequilibrium:   |
| Primary Ionization: (Reference)  E-Beam-   | Number of Laser Lines  Modeled: 2 (10.6 - 9.28)   |
| Self-Sustained:  | Source of Rate Coefficients Used in Code  |
| UV-Initiated:  | Various   |
| Others (specify):  |   |
|  | LINE PROFILE MODELS ( ):  |
| Secondary Ionization (Reference)   | Doppler Broadening:   |
| Attachment:  | Collisional Broadening:   |
| Detachment:  | Others (specify):   |
| Ion-Ion Recom-   |   |
|  | RECIRCULATION CONTAMINANTS  |
| Dissociation   | MODELED (√): None   |
| Recombination:   | O <sub>X</sub> : OH <sub>X</sub> :  |
| Others (specify):  | NO <sub>x</sub> : HNO <sub>x</sub> :  |
|  | Others (specify):   |
| Source of Rate Coefficients Used:  | REFERENCE FOR REACTION MECHANISM  |
| DISCHARGE POWER INPUT MODELED (V):   | AND RATES: various  |
| Uniform: Non-Uniform: V  | OTHER UNIONS PROTEINS   |
| E-Field:   | OTHER UNIQUE FEATURES:  |
| Others (specify):  |   |

## GAS DYNAMICS CODE

|   | CODE NAME: UNSEDL2   |
|---|--|
| . CODE STRUCTURE  | DECONTAMINATION METHOD TREATED ( <b>√</b> ):   |
| COORDINATE SYSTEM (√):  | Scrubber:  |
| Cartesian: V Expanding:   | Shower:  |
| FLUID GRID DIMENSIONALITY (V):  | Catalytic Reactor:   |
| 1-D:  | Others (specify):  |
| 2-D:  |  |
| 3-D:  |  |
| Time Dependent:   |  |
| FLOW FIELD MODELED (1):   | 4. ACOUSTIC ATTENUATION MODEL  |
| Compressible Flow:  | GENERAL FEATURES MODELED (√):  |
| Incompressible:   | Single Pulse: Repetitive Pulse:  |
| Viscous Flow;   | DIMENSIONALITY TREATED (1):  |
| No Flow:  | I-D:3-D:   |
| BASIC MODELING APPROACH (1):  | Time-Dependent;  |
| Algebraic: Integral Method:   | DISTURBANCE MODELED ( \square):  |
| l'inite Difference:   | Pressure Wave: Entropy Wave:   |
| Others (specify): actually finite   | Others (specify): disturbance propagated   |
| element   | by "hydro code" time dependent equations   |
| REFERENCE FOR APPROACH USED:  | WAVE PROPAGATION TREATMENT (√):  |
| MacCormack  | Linear Wave:   |
| MacCormank  | Nonlinear Wave:  |
|   | Others (specify):  |
| GAS DYNAMICS MODEL FEATURES:  | one of the control of |
| GAS SUPPLY MODELED (√):   | THEORETICAL BASIS: (Reference)   |
| Mixture Preparation:  |  |
| Mixture Injection:  |  |
| Nozzles: Variable Geometry  | NUMERICAL METHODOLOGY: (Reference)   |
| Flow Plates: Choked or face plate   |  |
| Others (specify):   |  |
|   | ACOUSTIC ATTENUATORS CONSIDERED (√): no  |
| CAVITY INITIAL CONDITION DETERMINED   | Muffler: Heat Exchanger:   |
| CAVITY INITIAL CONDITION DETERMINED<br>BY (specify): Solution of time dependent | Horn: Porous Wall:   |
| equations, no energy input.   | Others (specify):  |
|   | Others (specify):  |
| EXHAUST, RECIRCULATION MODEL  |  |
| GENERAL SYSTEM MODELED (√):   | 5. MODEL EFFECTS ON OPTICAL MODES DUE  |
| Open System: V Closed System:   | TO ( <b>√</b> ):   |
| Closed Cycle:   | Index of Refraction Variation?:  |
| EXHAUST SYSTEM FEATURES (√):  | Other (specify): gain variation  |
| Pressure Recovery:  |  |
| Ejector System:   |  |
| Compressor/Fan:   |  |
| Heat Exchanger:   | OTHER UNIQUE FEATURES:   |
| Gas Make-Up:  |  |
| Others (specify): A recovery pressure   |  |
| is specified.   |  |
|   |  |
|   |  |
|   |  |
|   |  |
|   |  |

# OPTICS CODE

CODE NAME: UNSEDL2

| Technique:  Power Comparison: Field Comparison: Others (specify): Acceleration Algorithms Used?:  Technique: MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS ( ): Prony: Others (specify): |
|---|
| Field Comparison:  Others (specify):  Acceleration Algorithms Used?:  NO  Technique:  MULTIPLE EIGENVALUE/EIGENVECTOR  EXTRACTOR ALGORITHMS ( ):  Prony:  |
| Others (specify):  Acceleration Algorithms Used?:  NO  Technique:  MULTIPLE EIGENVALUE/EIGENVECTOR  EXTRACTOR ALGORITHMS ( ):  Prony:   |
| Acceleration Algorithms Used?: NO  Technique:  MULTIPLE EIGENVALUE/EIGENVECTOR  EXTRACTOR ALGORITHMS ( ):  Prony:   |
| Technique:  |
| MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS ( ):  Prony:   |
| EXTRACTOR ALGORITHMS (✔):  Prony:   |
| Prony:  |
|   |
| Others (specify):   |
|   |
|   |
| RESONATOR MODELING FEATURES   |
|   |
| GENERAL CAPABILITIES:   |
| Stability ( $$ ):   |
| Stable Resonators:  |
| Unstable Resonators:  |
| Type (V)  |
| Standing Wave:  |
| Traveling Wave (Ring):  |
| Reverse   |
| Traveling   |
| Wave:<br>Branch (√):  |
| Positive: V   |
| Negative:   |
| Optical Element Models Included (1):  |
| Flat Mirrors; V   |
| Spherical Mirrors:  |
| Cylindrical   |
| Mirrors:  |
| Telescopes:   |
| Scraper Mirrors:  |
| Deformable Mirrors:   |
| Spatial Filters:  |
| Gratings (specify type):  |
| Other Elements (specify):   |
| PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List): Sets up confocal automatically;   |
|   |
| other resonators can be set up with<br>some additional minor difficulty.  |
|   |
|   |
|   |
|   |
|   |
|   |

Method (specify): \_

# OPTICS CODE

(Concluded)

CODE NAME: UNSEDL2

| IN MODELS (√): Bare Cavity Only:        |                      |
|---|----------------------|
| Simple Saturated                        |                      |
| Detailed Model (S<br>Section 3 in Kinet | ee e                 |
|   | MODIFIER MODELS (1): |
| Mirror Tilt:                            | *                    |
| Mirror Decentrat                        | ion:                 |
| Aberrations/Ther<br>Distortion          | rmal                 |
| Arbitrary;                              |                      |
| Selected (speci                         | ify):                |
| Reflectivity Loss;                      | :                    |
| Output Coupler F.                       | dges                 |
| Rolled:                                 |                      |
| Serrated                                |                      |
| Other:                                  |                      |
| ADED CAVITY FIEDDELS (1):               | LD MODIFIER          |
| refractive Index                        |                      |
| Variation:                              |                      |
| Gas Absarption:                         |                      |
| Overlapped Beam<br>Hux apdating         | Y                    |
| Number (Ove<br>Allowed:                 | can be easily set    |
| Others:                                 |                      |
|   |                      |
|   |                      |
| R FIELD MODELS                          | 12/1-                |
| Beam Steering Re                        |                      |
| Optimal Focal Sea                       |                      |
| Beam Quality:                           | N/                   |
| Atmospheric Prop                        | pagation             |
| Others:                                 |                      |
|   |                      |
| AM CONTROL SVS                          | TEM MODELED (1):     |
| Printer/Track<br>Subsystem:             |                      |
| Beam Jitter;                            |                      |
|   | *                    |
| Autoalienment                           | 1                    |
| Autoalignment:<br>Target Model:         |                      |

| CODE NAME: UVLZE                     | ТТ                     | ECHNICAL AREA(5): Kinetics   |
|--------------------------------------|------------------------|--|
| DEVICE COMPONENTS                    | TREATED: Laser         | Discharge, PFN   |
|                                      |                        | F CODE: Study kinetics of rare gas halide  |
| lasers, design                       | more efficient PI      | FN's.  |
|                                      |                        |  |
|                                      |                        |  |
| ASSESSMENT OF CAP                    | ABILITIES: Code de     | oes quite well at describing the electrical  |
|                                      |                        | nt, impedance) of RgH-discharge systems.   |
| In general code                      | also predicts la       | asing onset well.  |
|                                      |                        |  |
|                                      |                        | ume uniform gain and flux and this is bad.   |
|                                      | o-kinetics code.       | y predict output energy. Code requires   |
| separate electr                      | O-KINECICS COde.       |  |
|                                      | upus s                 |  |
|                                      |                        | n of the code has been modified to provide<br>SUPER SCEPTRE. This then permits modelling |
| of nearly any F                      |                        | SUPER SCEPTRE. THIS then permits modelling   |
| Or Hearty day                        | 7 74 0                 |  |
| ORIGINATOR/KEY CO                    | NIACI:                 |  |
| Name: Arthu                          |                        |  |
| Organization: 7                      | r-12, LASL             |  |
| Address: MS.                         | -569, Los Alamos       | Scientific Laboratory, Los Alamos, NM 87545  |
| Phone: 505-66                        | 57-7799                |  |
| AVAILABLE DOCUME                     | NTATION (Please spec   | ify, use T = Theory, U = User's Manual, L = Listing, and                                 |
| RP = Related Pul                     | olication);            | EEE J.Q.E. <u>14</u> , 951, 1978   |
| DD. A.E. Green                       | are CR Tallma          | n, W.L. Willis, & C.A. Brau, Proceedings of  |
|                                      |                        | n Lasers 1979, 211.  |
|                                      |                        |  |
|                                      |                        |  |
| STATUS:                              |                        |  |
| Opprational Com                      | ently 2. X             |  |
| Operational Curr<br>Under Modificati | on?: X                 |  |
| Purpose(s):                          | Work underway          | on moving from KrF to XeCl   |
| 1 4. post ; s),                      |                        |  |
|                                      |                        |  |
| Ownership?:                          | LASL is funded by      | DOE  |
| Proprietary?:                        |                        |  |
| MACHINE/OPERATING                    | G SYSTEM (on which in  | stalled): CDC-7600/LTSS  |
|                                      |                        |  |
| TRANSPORTABLE ?: _                   | y es                   |  |
| Machine Depende                      | ent Restrictions:      |  |
|                                      |                        |  |
| SELF-CONTAINED?                      | no                     | Mound land Baltonian counties to   |
|                                      |                        | NOMAD - solves Boltzmann equation to   |
|                                      | ron impact pumpin      |  |
|                                      | RCES REQUIRED FOR      |  |
| Small Job:                           | bre Size (Octal words) | Execution Time (sec, CDC 7600)   |
|                                      | 637                    | 12 coc   |
| Typical Job:                         | 03/                    | 12 sec   |
|                                      | mber of FORTRAN Line   | 600  |
|                                      | HOUS OF FORTRAN LINE   | **   |
| COMMENTS:                            |                        |  |
|                                      |                        |  |
|                                      |                        |  |

# KINETICS CODE

CODE NAME: UVLZR

| I. CODE STRUCTURE                              | 3. LASING KINETICS MODEL   |
|--|--|
| COORDINATE SYSTEM (√):                         | GENERAL (specify):   |
| Cartesian: V Expanding:                        | Lasing Species: KrF* or RgH*   |
| KINETICS GRID DIMENSIONALITY ( ):              | Number of Species: 1   |
| 1-D:   | Number of Reactions: 1   |
| 3-D:   | Other Major Species Considered: diluent  |
| GAIN REGION SYMMETRY RESTRICTIONS:             | Ne or He (or both), F, or halogen  |
| Gain Vary Along Optical Axis:                  | doner  |
| Flow Direction:                                | IMPACT EXCITATION MODELED (√):   |
| KINETICS MODELED: Pulsed: V CW:                | (Reference)  |
| NUMERICAL SCHEME USED IN RATE CALCULATION ( ): | Vibrational:   |
| Explicit:                                      | Electronic:  |
| Implicit:                                      | Others (specify):  |
| Others (specify):                              |  |
|  | ENERGY TRANSFER MODES MODELED ( ): (Reference)   |
|  | V-T:   |
| REFERENCE OF METHOD USED: Gear                 | V-R:   |
|  | V-V:   |
|  | Others (specify): Rg + H → RgH*  |
| 2. PLASMA EINETICS MODEL                       | Lasing Transition: P-Branch:   |
| NUMBER OF SPECIES TREATED (specify):           | R-Pranch:  |
| Number of Positive Species: 2                  | Single Line Model (V):   |
| North and China                                | Multi-Line Model (♥):  |
| Species:                                       | Assumed Rotational Population Distribution State (1):  |
| Number of Neutral Species: 4                   | Equilibrium:   |
| REACTION MECHANISM MODELED (1):                | Nazoquilibrum.   |
| Primary Ionization: (Reference)                | Number of Laser Lines Modeled:   |
| E-Beam;  | Modeled: 1   |
| Self-Sustained:                                | Source of Rate Coefficients Used in Code:  |
| UV-Initiated:                                  | see RP page #1   |
| Others (specify): Electron impact              |  |
| avalanche                                      | LINE PROFILE MODELS ( );   |
| Secondary Ionization (Reference)               | Doppler Broadening:  |
| Attachment:                                    | Collisional Broadening:  |
| Detachment:                                    | Others (specify):  |
| Ion-Ion Recom-                                 |  |
| bination:                                      |  |
| Charge Transfer:                               | 4. RECIRCULATION CONTAMINANTS MODELED (√): none  |
| Dissociation/<br>Recombination:                | O <sub>x</sub> : OH <sub>x</sub> :   |
| Others (specify):                              | NO <sub>x</sub> : HNO <sub>x</sub> :   |
|  | Others (specify):  |
| Source of Rate Coefficients Used: see          |  |
| RP on page 1                                   | REFERENCE FOR REACTION MECHANISM   |
| DISCHARGE POWER INPUT MODELED ( ):             | AND RATES:   |
| Uniform; Non-Uniform;                          | AND THE RESERVE AND THE PARTY OF THE PARTY O |
| E-Fleld:                                       | OTHER UNIQUE FEATURES: Numerous self   |
| Others (specify):time_varying                  | absorption terms included.   |
|  |  |
|  |  |

| CODE NAME: VIBI  | KIN TECHNICAL AREA(S): Ki  |  |
|--|--|--|
|  | NTS TREATED: Laser Cavity  |  |
|  | SE(S)/APPLICATION(S) OF CODE: To model the k   |  |
|  | bon monoxide mixed with helium and argon   |  |
| expansion pum  | ped by an electric discharge and unpumped  | by lasing.   |
|  |  |  |
|  |  |  |
|  | APABILITIES: The model predicts the time have in very good agreement with pulsed and   |  |
|  | ge scale devices.  | cw experiments in both   |
|  | 3- 3- 3- 3- 3- 3- 3- 3- 3- 3- 3- 3- 3- 3   |  |
| ASSESSMENT OF LI   | IMITATIONS: About \$50 cost per case to run  | •  |
|  |  |  |
|  |  |  |
|  |  |  |
|  | ATURES: Electron energy distribution from  |  |
|  | ifold changes. Includes vibration excita   |  |
|  | levels. Modified Rigrod theory for laser   |  |
| dependent vv   | and VT rates and optical boradening cross CONTACT: /flow eqns. with heat addition.   | Potational thermal equilibriu  |
| ORIGINATOR/KEY (   | ild John Nelson, MS 88-46 /Includes CO R-  | branch resonance effects.  |
|  | The Boeing Aerospace Company   |  |
| Address. P   | P.O. Box 3999 Seattle, WA 98124  |  |
| Add. css.  |  |  |
| Phone: (206  | 1 773-1498   |  |
| Phone: (206<br>AVAILABLE DOCUM   |  | s Manual, L = Listing, and   |
| AVAILABLE DOCUM<br>RP = Related 1  | MENTATION (Please specify, use T = Theory, U = User'<br>Publication): The report: AFWL-TR-75-256 Su  |  |
| AVAILABLE DOCUM<br>RP = Related 1<br>(SCOL Code),  | MENTATION (Please specify, use T = Theory, U = User'<br>Publication): The report: AFWL-TR-75-256 Su<br>D.J. Pistores: and D.J. Nelson describes  | the theory and the   |
| RP = Related (SCOL Code), comparison of  | MENTATION (Please specify, use T = Theory, U = User'<br>Publication): The report: AFWL-TR-75-256 Su<br>D.J. Pistores: and D.J. Nelson describes<br>some results with experiments. The repo   | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM<br>RP = Related !<br>(SCOL Code),<br>comparison of<br>CO Laser Code  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Str. D.J. Pistores: and D.J. Nelson describes some results with experiments. The report, Operations Manual, E.G. Cate, D.J. Nelson   | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM<br>RP = Related !<br>(SCOL Code),<br>comparison of<br>CO Laser Code  | MENTATION (Please specify, use T = Theory, U = User'<br>Publication): The report: AFWL-TR-75-256 Su<br>D.J. Pistores: and D.J. Nelson describes<br>some results with experiments. The repo   | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM<br>RP = Related !<br>(SCOL Code),<br>comparison of<br>CO Laser Code<br>the usage of  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Str. D.J. Pistores: and D.J. Nelson describes some results with experiments. The report, Operations Manual, E.G. Cate, D.J. Nelson   | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM<br>RP = Related !<br>(SCOL Code),<br>comparison of<br>CO Laser Code<br>the usage of<br>STATUS:   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Su D.J. Pistores: and D.J. Nelson describes some results with experiments. The report, Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.   | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Co   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Support  | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Co   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Su D.J. Pistores: and D.J. Nelson describes some results with experiments. The report, Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  urrently?: Yes  sation?: Only slowly   | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Co   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Support  | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Co   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Su D.J. Pistores: and D.J. Nelson describes some results with experiments. The report, Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  urrently?: Yes  sation?: Only slowly   | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM RP = Related (SCOL Code), comparison of CO Laser Code the usage of STATUS: Operational Co Under Modific Purpose(s  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Su D.J. Pistores: and D.J. Nelson describes some results with experiments. The report, Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  urrently?: Yes  sation?: Only slowly   | the theory and the ort: AFWL-TR-76-5 Supersonic  |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Co Under Modific Purpose(s  Ownership?: Proprietary?:  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Su D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  **Comparison of the code and contains a source listing.**  **Code and code and contains a source listing.**  **Code and code and c | the theory and the ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe   |
| AVAILABLE DOCUM RP = Related !  (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s  Ownership?: Proprietary?: MACHINE/OPERAT   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Su D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  **Comparison of the code and contains a source listing.**  **Code and code a | the theory and the ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe   |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Country Under Modific Purposets  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Str. D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  Surrently?: yes Station?: Only slowly Sh: to continue improving the performance  AFWL and Boeing  SING SYSTEM (on which installed): IBM 360/370/3032  AFWL   | the theory and the ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe   |
| AVAILABLE DOCUM RP = Related !  (SCOL Code),  comparison of CO Laser Code the usage of  STATUS:  Operational Country Under Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A  TRANSPORTABLE?  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 St D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  Surrently?: yes Station?: Only slowly Sh: to continue improving the performance  AFWL and Boeing  SING SYSTEM (on which installed): IBM 360/370/3032  AFWL Sh: yes   | the theory and the ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe descr |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A TRANSPORTABLE? Machine Dependence   COMPART   Machine Dependence   Machi | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Su D.J. Pistores: and D.J. Nelson describes some results with experiments. The report, Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  urrently?: yes sation?: Only slowly s): to continue improving the performance  AFWL and Boeing  TING SYSTEM (on which installed): IBM 360/370/3032 AFWL c: yes ndent Restrictions: A few statements were characteristic and the statement and th | the theory and the ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe descr |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A  TRANSPORTABLE? Machine Dependent   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Str. D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  The report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the report of the code and contains a source listing.  The report of the rep | the theory and the ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe descr |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A  TRANSPORTABLE? Machine Dependence of the usage of  Machine Dependence of the usage of  Machine Dependence of the usage of the usage of  SELF-CONTAINED?  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 St D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  The report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the report of the code and contains a source listing.  The report of the report: The report of the report of the code and contains a source listing.  The report of the report o | the theory and the ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe descr |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A  TRANSPORTABLE? Machine Dependence of the usage of  Machine Dependence of the usage of  SELF-CONTAINED?   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 Str. D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  The report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the code and contains a source listing.  The report of the report of the report of the report of the code and contains a source listing.  The report of the rep | the theory and the ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe descr |
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| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A TRANSPORTABLE? Machine Dependent of the Codes R Other Codes R   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 St D.J. Pistores: and D.J. Nelson describes  some results with experiments. The report; Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  urrently?: Yes sation?: Only slowly s): to continue improving the performance  AFWL and Boeing  TING SYSTEM (on which installed): IBM 360/370/3032 AFWL c: Yes ndent Restrictions: A few statements were channel CDC machines.  Programment of the statement of the code and CDC machines.  Sequired (name, purpose):  COURCES REQUIRED FOR RUNS: Core Size (Octal Words)   Execution Time (sec, CDC)   | the theory and the Ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe Real Boeing, Real |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A TRANSPORTABLE? Machine Dependent of the Codes R Other Codes R   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 St D.J. Pistores: and D.J. Nelson describes  some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  urrently?: Yes Pation?: Only slowly  sh: to continue improving the performance  AFWL and Boeing  TING SYSTEM (on which installed): IBM 360/370/3032  AFWL  Stripped Syste | the theory and the Ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe ortical and and another and another ano |
| AVAILABLE DOCUM RP = Related !  (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A  TRANSPORTABLE? Machine Dependence IBM a  SELF-CONTAINED? Other Codes R  ESTIMATE OF RESC  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 St D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  """ """ """ """ """ """ """ """ """  | the theory and the Ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe Reat Boeing, Reat Boeing, Reat Boeing, Resec pulse Resec pulse Resec pulse Resec pulse  |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purpose(s)  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A TRANSPORTABLE? Machine Dependence of LBM a SELF-CONTAINED? Other Codes R  ESTIMATE OF RESC  | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 St D.J. Pistores: and D.J. Nelson describes  some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  urrently?: Yes Pation?: Only slowly  sh: to continue improving the performance  AFWL and Boeing  TING SYSTEM (on which installed): IBM 360/370/3032  AFWL  Stripped Syste | the theory and the Ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe Reat Boeing, Reat Boeing, Reat Boeing, Resec pulse Resec pulse Resec pulse Resec pulse  |
| AVAILABLE DOCUM RP = Related   (SCOL Code), comparison of CO Laser Code the usage of  STATUS: Operational Counder Modific Purposets  Ownership?: Proprietary?: MACHINE/OPERAT CDC 6600 at A TRANSPORTABLE? Machine Dependent IBM a SELF-CONTAINED? Other Codes R  ESTIMATE OF RESC   | MENTATION (Please specify, use T = Theory, U = User' Publication): The report: AFWL-TR-75-256 St D.J. Pistores: and D.J. Nelson describes some results with experiments. The report: Operations Manual, E.G. Cate, D.J. Nelson the code and contains a source listing.  """ """ """ """ """ """ """ """ """  | the theory and the Ort: AFWL-TR-76-5 Supersonic on and D.J. Pistores: describe Reat Boeing, Reat Boeing, Reat Boeing, Resec pulse Resec pulse Resec pulse Resec pulse  |

### KINETICS CODE

CODE NAME: VIBKIN

1. CODE STRUCTURE 3. LASING KINETICS MODEL COORDINATE SYSTEM ( ): GENERAL (specify): Cartesian: V Expanding: Carbon Monoxide Lasing Species: KINETICS GRID DIMENSIONALITY ( ): Number of Species: 1-D: V 2-D: Number of Reactions: 3-D: \_\_ Other Major Species Considered: Helium and Argon GAIN REGION SYMMETRY RESTRICTIONS: Gain Vary Along Optical Axis: Flow Direction: V IMPACT EXCITATION MODELED ( ): KINETICS MODELED: Pulsed: V CW: V (Reference) # NUMERICAL SCHEME USED IN RATE  $\sqrt{17,23,30,32}$ Vibrational: CALCULATION ( ): Explicit: 5th order Runge-Kutta for vibration kinetics Implicit: tridiagonal iteration for electron distribution Others (specify);\_ ENERGY TRANSFER MODES MODELED ( ): (Reference) \* REFERENCE OF METHOD USED: \_ V-R: \_ 8,9,33 Others (specify):\_ 2. PLASMA EINETICS MODEL Lasing Transition: P-Branch: V NUMBER OF SPECIES TREATED (specify): R-Branch: resonances wi Number of Positive Single Line Model ( ): Species: Multi-Line Model ( 1): Number of Negative Assumed Rotational Population Species: Distribution State ( ): Number of Neutral Species: Equilibrium: REACTION MECHANISM MODELED ( V ): Nonequilibrium: (Reference) Number of Laser Lines on each of determines electron density Modeled. 5-rotational lines on each of Primary Ionization: E-Beam: Source of Rate Coefficients Gred in Code: determines pumping rates Self-Sustained: V UV-Initiated: Others (specify): LINE PROFILE MODELS ( ): Doppler Broadening: Secondary Ionization (Reference) Collisional Broadening: Attachment; Others (specify): Voigt Detachment: Ion-lon Recombination: 4. RECIRCULATION CONTAMINANTS Charge Transfer: MODELED (√): None Dissociation/ O<sub>x</sub>: \_\_\_\_ OH<sub>x</sub>: \_\_\_\_ NO<sub>x</sub>: \_\_\_\_ HNO<sub>x</sub>: \_\_\_\_ Recombination: Others (specify): Others (specify): Source of Rate Coefficients Used: REFERENCE FOR REACTION MECHANISM AND RATES:\_ DISCHARGE POWER INPUT MODELED (V): Uniform: V Non-Uniform: OTHER UNIQUE FEATURES: E-Field: \* See reference on AFWL-TR-75-256 Others (specify): Function of time

| ODE NAME: XENON  | TECHNICAL AREA(S): Kinetics  |
|--|--|
| EVICE COMPONENTS TREATED: _  |  |
|  | ION(S) OF CODE: Synthesis of E-Beam initiated  |
| Ar-X laser.  |  |
|  |  |
|  |  |
| SSESSMENT OF CADABILITIES. C   | alculates saturated power density for an E-Beam  |
|  | d Ar-Xe laser using 10-20 rate equations   |
| Interacea discharge pumper   | a Al ne label abing to be take equations   |
|  |  |
| SSESSMENT OF LIMITATIONS:_ BO  | oltzman code needed to calculate rate constants.   |
|  |  |
|  |  |
| THER UNIQUE PEATURES. Colli  | ision effect on excited states treated implicitly.   |
| THER UNIQUE FEATURES: COIL   | ision effect on excited states treated implicitly.   |
|  |  |
|  |  |
| RIGINATOR/KEY CONTACT:   | •  |
| Name: T. DeTemple  |  |
| Organization: U. of Ill.   |  |
| Address: 200 EERL, Urba  | na, ILL 61801  |
| Phone: 217-333-3094  |  |
| VAILABLE DOCUMENTATION (Plea   | ase specify, use T = Theory, U = User's Manual, L = Listing, and                                       |
| RP = Related Publication):   |  |
| SA Lauton IR Dich  | parde L. A. Netman I. Specht and T. A. Delemble  |
|  | nards, L.A. Newman, L. Specht, and T.A. DeTemple,  |
| "The High Pressure Neu   | nards, L.A. Newman, L. Specht, and T.A. DeTemple, atral Infrared Xenon Laser", J.A.P. Vol. 50, p. 3888 |
| "The High Pressure Neu<br>3898. June 1979. (RP)  | itral Infrared Xenon Laser", J.A.P. Vol. 50, p. 3888   |
| "The High Pressure Neu<br>3898. June 1979. (RP)  |  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  | itral Infrared Xenon Laser", J.A.P. Vol. 50, p. 3888   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  | remple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  TATUS: Operational Currently?:  | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  CATUS: Operational Currently?:  | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  "ATUS: Operational Currently?:  | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  FATUS: Operational Currently?: Under Modification?: Purpose(s):   | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  FATUS: Operational Currently?: Under Modulication?: Purpose(s): Ownership?:   | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  ATUS: Operational Currently?:   | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  (ATUS: Operational Currently?:  | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  TATUS: Operational Currently?: Under Modufication?: Purpose(s): Ownership?: Proprietary?: NO ACHINE/OPERATING SYSTEM (on  | Temple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (   |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  TATUS: Operational Currently?:  | which installed): CYBER 175  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  TATUS: Operational Currently?: Under Modufication?: Purpose(s): Ownership?: Proprietary?: NO ACHINE/OPERATING SYSTEM (on  | which installed): CYBER 175  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  TATUS: Operational Currently?: Under Modification?: Purpose(s): Ownership?: Proprietary?: Proprietary?: NO ACHINE/OPERATING SYSTEM (on RANSPORTABLE?: Yes Machine Dependent Restrictions  | which installed): CYBER 175  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  GATUS: Operational Currently?:  | which installed): CYBER 175  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  TATUS: Operational Currently?:  | which installed): CYBER 175  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  TATUS: Operational Currently?: Under Modufication?: Purpose(s): Ownership?: Proprietary?: Proprietary?: NACHINE/OPERATING SYSTEM (on RANSPORTABLE?: Yes Machine Dependent Restrictions ELF-CONTAINED?: Other Codes Required (name, property)  | which installed): CYBER 175  Calcomp  CALCOMP  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  TATUS: Operational Currently?: Under Modification?: Purpose(s): Ownership?: Proprietary?: Proprietary?: NO ACHINE/OPERATING SYSTEM (on RANSPORTABLE?: Yes Machine Dependent Restrictions  | which installed): CYBER 175  CALCOMP  CALCOMP  CALCOMP  CALCOMP  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  FATUS: Operational Currently?: Under Modufication?: Purpose(s):  Ownership?: Proprietary?: Proprietary?: NO ACHINE/OPERATING SYSTEM (on RANSPORTABLE?: Yes Machine Dependent Restrictions ELF-CONTAINED?: Other Codes Required (name, positional codes required) STIMATE OF RESOURCES REQUIRES                            | which installed): CYBER 175  Calcomp  CALCOMP  CALCOMP  CALCOMP  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  FATUS: Operational Currently?: Under Modufication?: Purpose(s):  Ownership?: Proprietary?: NO ACHINE/OPERATING SYSTEM (on RANSPORTABLE?: Yes Machine Dependent Restrictions ELF-CONTAINED?: Other Codes Required (name, positional codes Required (name, positional codes Required (name))  STIMATE OF RESOURCES REQUIRED | which installed): CYBER 175  Calcomp  CALCOMP  CALCOMP  CALCOMP  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. Del  IATUS: Operational Currently?: Under Modufication?: Purpose(s):  Ownership?: Proprietary?: Proprietary?: No ACHINE/OPERATING SYSTEM (on RANSPORTABLE?: Yes Machine Dependent Restrictions ELF-CONTAINED?: Other Codes Required (name, postimate of RESOURCES REQUIR) Core Size (Octal Small Job:                          | which installed): CYBER 175  Calcomp  CALCOMP  CALCOMP  CALCOMP  |
| "The High Pressure Neu 3898. June 1979. (RP) S. Lawton and T.A. DeT  S. Lawton and T.A. DeT  GATUS: Operational Currently?:  | which installed):CALCOMP  ED FOR RUNS:CALCOMP  |

| CODE STRUCTURE                                    | 3. LASING KINETICS MODEL                                      |
|---|---|
| COORDINATE SYSTEM (1):                            | GENERAL (specify):  |
| Cartesian: V Expanding:,                          | Lasing Species: Xe  |
| KINETICS GRID DIMENSIONALITY (1):                 | Number of Species: 2  |
| 1-D: 2-D:   | Number of Species: 2  |
| 3-D:  | Other Major Species Considered: Molecular                     |
| GAIN REGION SYMMETRY RESTRICTIONS:                | Ions, R.C. Molecules  |
|   | 1005, R.C. Molecules  |
| Gain Vary Along Optical Axis;                     |   |
| Flow Direction:                                   | IMPACT EXCITATION MODELED (♥):                                |
| KINETICS MODELED: Pulsed: V CW:                   | (Reference)   |
| NUMERICAL SCHEME USED IN RATE<br>CALCULATION (√): | Vibrational:  |
| Explicit:   | Electronic:   |
| Implicit:   | Others (specify): Excited State                               |
| Others (specify):                                 |   |
|   | ENERGY TRANSFER MODES MODELED ( ):                            |
|   | (Reference)   |
| REFERENCE OF METHOD USED: Gear                    | V-T:  |
| Method  | V-R:  |
| 1,20,100  | V-V:  |
| D. LOLL WINDTIGO MODEL                            | Others (specify): Electronic                                  |
| PLASMA KINETICS MODEL                             | Lasing Transition: P-Branch:                                  |
| NUMBER OF SPECIES TREATED (specify):              | R-Branch:   |
| Number of Positive Species: 5                     | Single Line Model ( ):  |
| Number of Negative 1                              | Multi-Line Model (√):   |
| Species:  | Assumed Rotational Population Distribution State (√):         |
| Species:  | Equilibrium:  |
| REACTION MECHANISM MODELED (√):                   | Nonequilibrium:   |
| Primary Ionization: (Reference)                   | Number of Laser Lines   |
| E-Beam:   | Modeled: 1  |
| Self-Sustained:                                   | Source of Rate Coefficients Used in Code;                     |
| UV-Initiated:                                     | Various   |
| Others (specify):                                 |   |
|   | LINE PROFILE MODELS ( 1:                                      |
| Secondary ionization (Reference)                  | Doppler Broadening:   |
| Attachment:                                       | Collisional Broadening:                                       |
| Detachment:                                       | Others (specify):   |
| Ion-Ion Recom-                                    |   |
| bination;   |   |
| Charge Transfer:                                  | 4. RECIRCULATION CONTAMINANTS                                 |
| Dissociation/<br>Recombination;                   | MODELED ( <b>√</b> ): none O <sub>X</sub> : OH <sub>X</sub> : |
| Others (specify):                                 | NO <sub>x</sub> : HNO <sub>x</sub> :                          |
| J. 10 percent 11.                                 | Others (specify):   |
| Source of Rate Coefficients Used:                 |   |
| various   | REFERENCE FOR REACTION MECHANISM                              |
| DISCHARGE POWER INPUT MODELED (1):                | AND RATES:  |
| Uniform: Non-Uniform:                             |   |
|   | OTHER UNKNUE FEATURES: Corrects for exc                       |
| E-Field:  | state dependence on electron distribut                        |
| Others (specify):                                 | function.   |

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